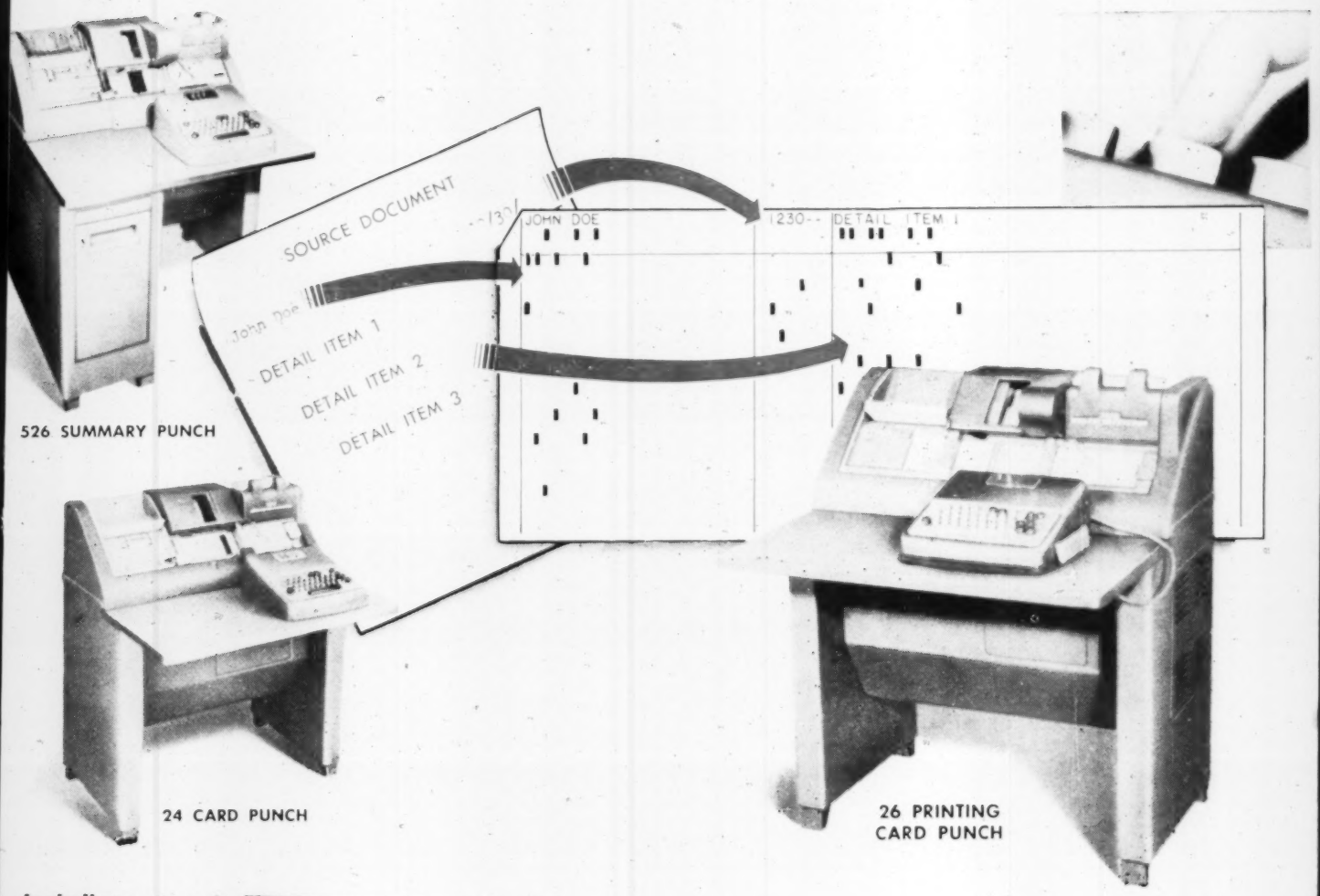
INSTRUMENTS and AUTOMATION

Punched cards are first step in automatic data processing ....page 782



Including: SIMULATION COUNCIL *Newsletter*

and The Journal of the SCMA

Vol. 28, No. 5
MAY 1955

TAKE NO CHANCES WITH SLIGHT LEAKAGE

APPLICATION: Where even slight leakage of a flowing medium might become obnoxious, dangerous or excessively expensive.

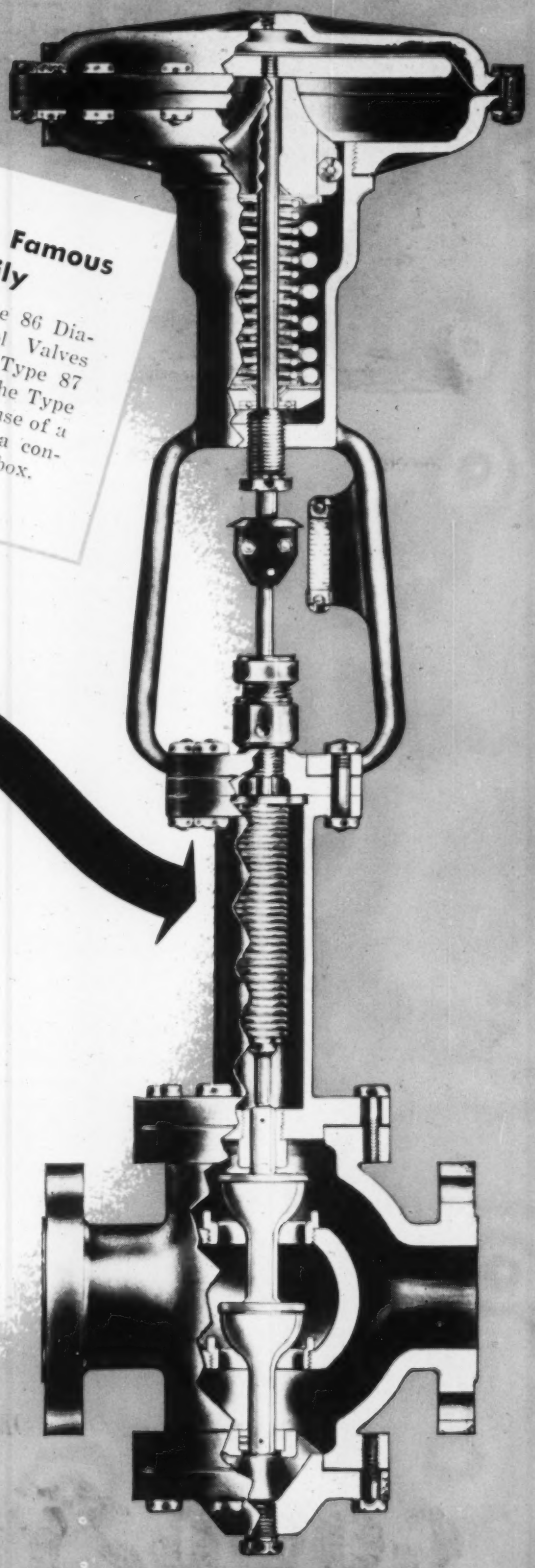
Specify

BS&B CLIMAX

Type 87 Diaphragm Control Valves

From The Famous Family

of Climax Type 86 Diaphragm Control Valves . . . the NEW Type 87 . . . identical to the Type 86 except for the use of a bellows seal plus a conventional stuffing box.



. . . with bellows sealed stem

Constantly striving to improve an already satisfactory item—that's part of the BS&B policy, part of our way of doing business. For example, take BS&B Climax Type 86 Diaphragm Control Valves of which the Type 87 is a family member. All Climax Type 87 valve bodies are designed to conform to I. S. A. tentative face-to-face standards. New designs continue to feature BS&B's interchangeability-of-parts advantage for greater operating and maintenance economy.

Type 87 is manufactured for all services and in all materials that are contemplated by Type 86 and in sizes from ½" to 6". Bellows can be supplied in bronze, stainless steel, Monel, Hastelloy "B", Nickel or other special alloys suitable. Maximum working pressure 400 lbs. cwp. The conventional teflon packed stuffing box is installed at the point the valve stem passes out of the bellows casing to forestall any appreciable loss of flowing medium in case of bellows failure.

Ask your BS&B MAN...33 Branches...13 Sales Offices...Ask for New Climax Catalog Section 105—recently revised—or write Black, Sivalls & Bryson, a leader for 60 years in oil and gas producing and refining equipment...out in front with controls and equipment for the processing industries.

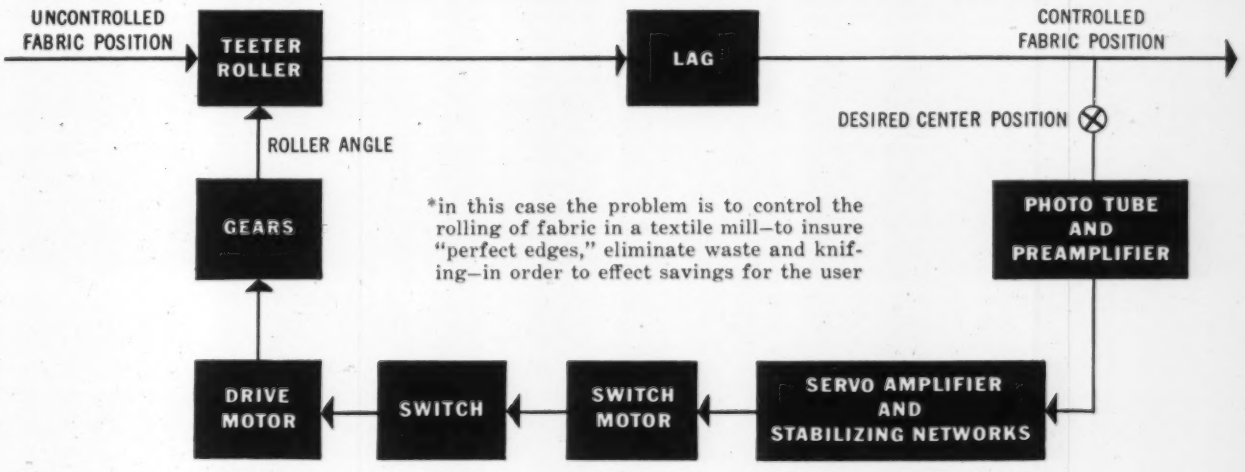
CLIMAX BS&B CONTROLS

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V5

7500 East 12th St. **Kansas City 3, Missouri**

For more information circle 1 on inquiry card.



*in this case the problem is to control the rolling of fabric in a textile mill—to insure "perfect edges," eliminate waste and knifing—in order to effect savings for the user

IT MAKES NO DIFFERENCE if the problem shown above is not similar to one facing you right now. The big point is this:

GEDA—versatile analog computing equipment built by Goodyear Aircraft—can speed the analysis and solution of difficult automatic control and engineering design problems *facing almost ANY type of industry.*

YOU SIMPLY set up your own problem, inject your own control characteristics—and "feed" it to GEDA.

IT IS BY FAR the simplest and most assured way to eliminate hit-or-miss experimentation and empirical "guesswork." You'll find GEDA is as easy to use as it is versatile—delivers results in wave forms and voltages for easy translation without requiring learning of specialized mathematics.

A VITAL ENGINEERING TOOL, GEDA can deliver tremendous savings in engineering man-hours—possesses quality and flexibility foremost in its field.

WRITE FOR LITERATURE which describes the complete line of GEDA "Advanced Design" Computing Equipment: Goodyear Aircraft Corporation, 931EE, Akron 15, Ohio.

GEDA *ANALOG COMPUTERS — best way to give your hunch a chance!*

GOODYEAR AIRCRAFT

GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

For more information circle **2** on inquiry card.

if it's **METAL FABRICATION**

your **FALSTROM** man has the answer!

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panel boards
small parts
enclosures
cubicles
housings
chassis
consoles

- fabrication of large or small shapes to close tolerances.
- fabrication in aluminum, sheet steel, stainless steel, copper, brass and other alloys.
- complete design-engineering-production service.
- stock tools, dies, jigs . . . standard fabricating techniques employed wherever possible.
- modern facilities for punching, shearing, bending, welding, finishing.

Write for literature, bulletin 143A on Falstrom enclosures, or send prints for analysis by trained engineers, without obligation.

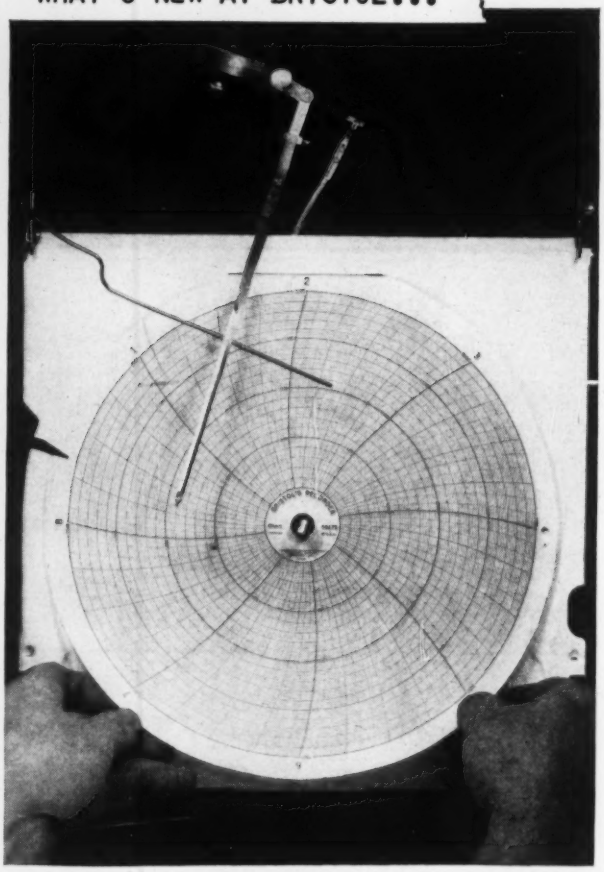
Falstrom means it's that much better!

FALSTROM

FALSTROM COMPANY, 93 Falstrom Court, Passaic, N. J.
PRescott 7-0013 **Since 1870**

For more information circle **3** on inquiry card.

WHAT'S NEW AT BRISTOL...



Whose charts should you buy?

If you're using Bristol instruments, the answer's evident — genuine Bristol charts. Here's why:

1. Charts are the scales to which the instruments are calibrated. They must be engineered and manufactured under the same quality controls used for other precision parts of the instruments.
2. Special papers and special printing presses are required. No instrument manufacturer can control chart quality without direct control of his materials and machines.
3. The Bristol Company can provide better service for Bristol Instruments if genuine charts are used. Bristol recorder pens and ink are designed for use with Bristol charts.
4. The Bristol Company cannot guarantee the accuracy of your Bristol recorder if you do not use genuine Bristol charts.

If you want to know more about how important chart quality is, write for our Bulletin Y-1904, "The Bristol Chart Story". The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 5.10

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BRISTOL

Points the Way in Human-Engineered Instrumentation

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **4** on inquiry card.

Contents...

Vol. 28, No. 5 May 1955

INSTRUMENTS and AUTOMATION

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Editorial

IRE Show 723

CIO Automation Conference 723

AIEE Conference on Magnetism and Magnetic Materials 724

Feature Articles

Electronic Data-processing Machines 782
by George Truman Hunter and Graham M. Clark

Process Control Analysis 794
by Millard H. La Joy and E. Allen Baillif

Electronic Circuitry 798
by Milton H. Aronson and Charles F. Kezer

Instrument Air Dryers 800
by G. L. Simpson

The Simulation Council Newsletter

..... 803

Journal of the Southern California Meter Association

Level Control 809
by Arthur E. Fleming

Other Regular Features

Trends 695
News (Principles and Applications) 696
New Instruments 726
Test Your I.Q. 778
Events Calendar 780
Briefs 816
New Literature 824
Searchlite Section 842
Advertisers' Index 844
Inquiry Card 845

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PROVEN by 8 years

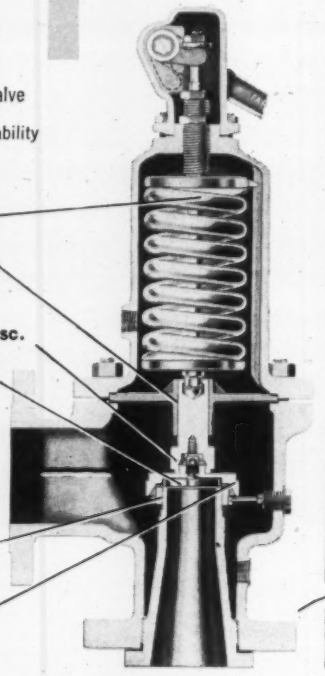
THOUSANDS of Successful Installations of Farris "4 in 1" Safety Relief Valves*

NOTICE: Farris Safety Relief Valves, the Internal Heat Exchanger, and Bellows construction are covered by U.S. Patents and Patents Pending. Copyrights, where applicable, are registered.

1 STANDARD FULL NOZZLE SAFETY RELIEF VALVES

Here is the ultimate in nozzle valve construction with complete standardization and interchangeability in every part:

- Round wire springs calibrated for rating.
- 2½ to 1 guiding ratio, close tolerances.
- Alignment spool for perfect alignment and bearing from stem to disc.
- Self-aligning, optically-flat replaceable disc of forged Stainless Steel.
- All bearings of hardened Stainless Steel.
- Expanded orifices increase capacity.
- Single blowdown ring does not affect capacity—simple adjustment.
- Flared disc-holder for ultimate operating efficiency.



BALANSEAL© SAFETY RELIEF VALVES

BalanSeal construction isolates all working parts. It consists of a neutral area bellows equalling the area of the seating surface, incorporating a mechanically-held seal for the lower part to greatly enhance replacement. BalanSeal can be simply installed any time. Because BalanSeal neutralizes effects of back pressures, resulting in a constant, safe relieving point on the upstream side, size of back pressure piping can be drastically reduced—for pipe savings up to 15 times the cost of the valve! Where accurate set points must be depended upon, BalanSeal stands alone.

For eight years Farris has been setting-the-pace-in-safety with "4-in-1" Safety Relief Valves, the "standard" for long service life, minimum maintenance and positive protection.

Farris' recognition as the pace-setter of the industry is no accident, but the result of many engineering "firsts" in improved valve design—FIRST with balanced bellows construction . . . FIRST to offer multiple nozzle sizes within one valve . . . FIRST with a line of bar stock safety-relief valves for pressures to 10,000 lbs. . . . FIRST to offer internal heat exchangers . . . FIRST to offer realistic pricing, giving the customer the benefit of manufacturing economies . . . and only Farris can point to proved-in-service performance . . . because Farris is the pioneer manufacturer of safety relief valves with bellows.

FOR ENGINEERS: Catalog 48Ra on the full line of Farris Safety Relief Valves; and Technical Manual 51B—"Principles of Manifold Discharge Piping". Available on request.

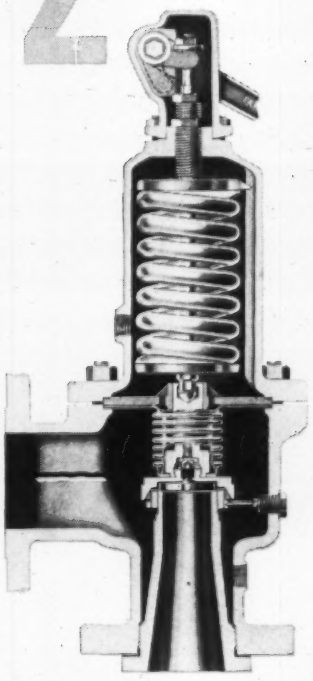
"THE FOX AND THE HARE"

Send for this popular entertaining pamphlet presenting a story about the recognition of BALANSEAL valves. It is humorous and enlightening. Just ask for it by name.

For more information circle 5 on inquiry card.

# of ACTUAL SERVICE

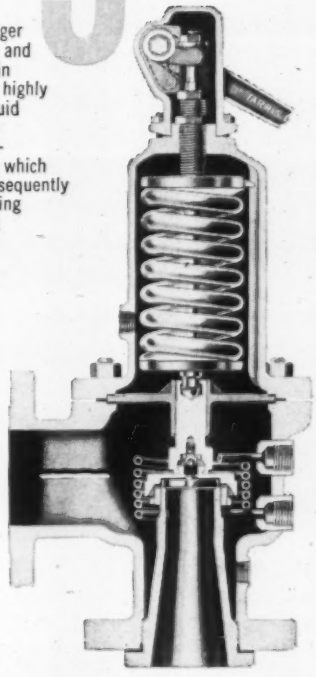
2



INTERNAL HEAT EXCHANGER

The exclusive Farris Internal Heat Exchanger eliminates inefficient and costly steam tracing in a valve body to keep highly viscous media in a fluid state. It consists of a stainless steel coil inserted in the body to which steam is fed and subsequently trapped out. For placing heat where it is most effective, increasing efficiency, lowering steam consumption, the Farris Internal Heat Exchanger is the only available product of its kind.

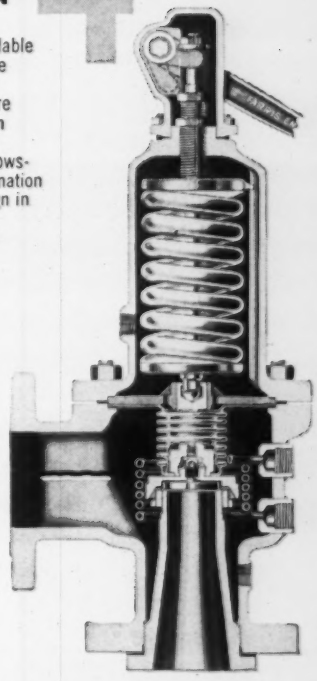
3



BELLOWS—HEAT EXCHANGER COMBINATION

For completely dependable valve operation in spite of sticky fluids (tars, asphalt, etc.) and where complete freedom from contamination is required, select the Bellows-Heat Exchanger combination . . . The ultimate design in safety relief valves for applications where material is highly viscous. All parts are Farris Standard construction.

4



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and Still the Lowest Prices in the industry!

Coming Soon!

An added line of ultimate capacity nozzle valves

Farris ENGINEERING CORPORATION

415 COMMERCIAL AVE., PALISADES PARK, NEW JERSEY

Affiliates: Farris Flexible Valve Corp. • Farris Stăcon Corp. • Farris HydroTorque Corp. Farris HydroSeal Corp. • Farris Pickering Governor Co.

For more information circle **5** on inquiry card.

FIRST instrument system BASIC GRAPHIC-PANEL

It's BRISTOL'S new metagraphic instrument system

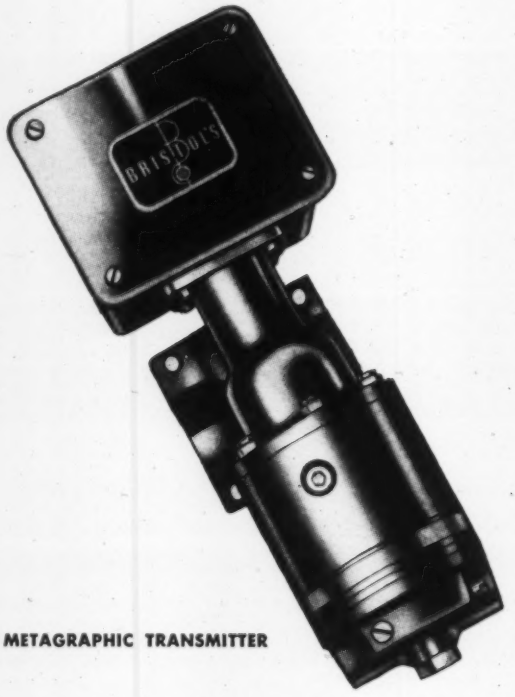
A WIDE SELECTION: For example, there are 35 receiver and 34 controller models and the widest variety of transmitters on the market. A model can be found among these that will exactly meet any requirement.

FULL PLUG-IN SERVICE: Change recorder to an indicator or vice versa in 10 seconds with ABSOLUTELY NO INTERRUPTION WHATSOEVER TO AUTOMATIC CONTROL.

Pull complete chassis out (one piece chassis — no tools required). With chassis removed you get the same automatic control as before.

Change from one model to another or if trouble is suspected in a plug-in unit, the doubtful unit can be replaced by a spare while the suspected unit is checked in the service shop — out-of-service time is thus eliminated.

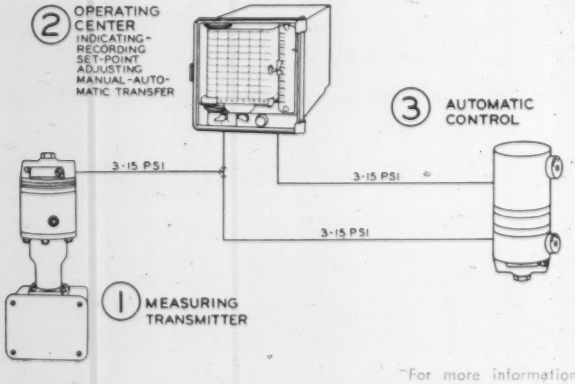
CONTINUOUS VALVE POSITION INDICATION on *same instrument scale as set point scale*, gives continuous data on control valve position—makes "bumpless" transfer possible, simply by matching pointer positions — no need to read actual scale values — minimizes reading errors — speeds operations.



METAGRAPHIC TRANSMITTER

SUPPLIED IN A VERY WIDE VARIETY OF SPANS AND RANGES: For example, absolute pressure instruments are made in ranges as low as 5mm mercury absolute. Pressure instruments as low as 5 inches water to 10,000 psi. Over-range protection available up to 400% over range.

STANDARD BRISTOL MEASURING ELEMENTS ARE USED — high torque, wide-angle travel gives powerful, positive operation. Very sensitive — as little change as 0.03% of range, including reversal.

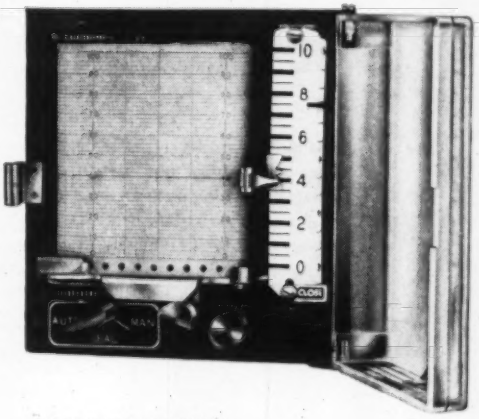


METAGRAPHIC INSTRUMENTS MEASURE, RECORD, INDICATE, AND AUTOMATICALLY CONTROL

Pressure	Liquid Level
Vacuum	Flow
Absolute Pressure	Temperature and
Differential Pressure	Mechanical Motion

For more information circle 6 on inquiry card.

that carries out idea completely!

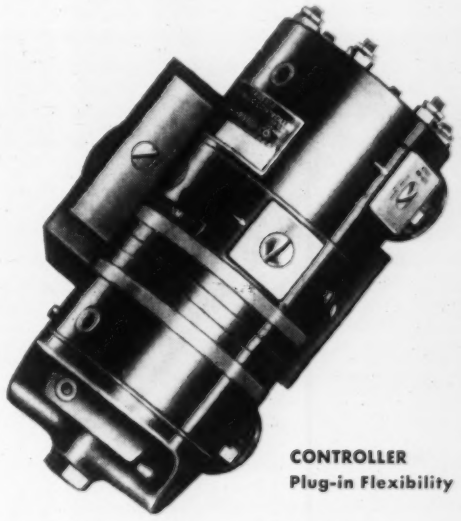


RECORDING RECEIVER:
Also furnished as an Indicator

NO INTERRUPTION WHATEVER TO AUTOMATIC CONTROL when receiver chassis is removed. The chassis of a Metagraphic Receiver is plug-in construction and can be changed from a recorder to an indicator or back in a matter of 10 seconds.

OFFERED FOR UP TO 3 MEASURED VARIABLES — with air pressure regulators or air-loaded regulators — three-position manual-automatic transfer valves for automatic control and *six-position (on the same knob) transfer valves for cascaded control.*

ALL MEASUREMENTS ON SAME SCALE PLATE: Deviation of pointers shows at a glance conditions of control — no need to read scale.



CONTROLLER
Plug-in Flexibility

VARIETY AND FLEXIBILITY: The most flexible and complete line of controllers offered — 34 different models, including the following variations:

1. Remote set-point
2. Integral set-point (with or without air-loading)
3. Pipe-connected
4. Plug-in receiver mounted
5. Plug-in pipe or surface mounted
6. Five models of control action as follows:
   a. On-Off
   b. Adjustable proportional
   c. Adjustable proportional plus reset
   d. Fixed proportional plus reset
   e. Proportional plus reset plus rate (derivative)

Write for our product data sheets. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

6.5.2

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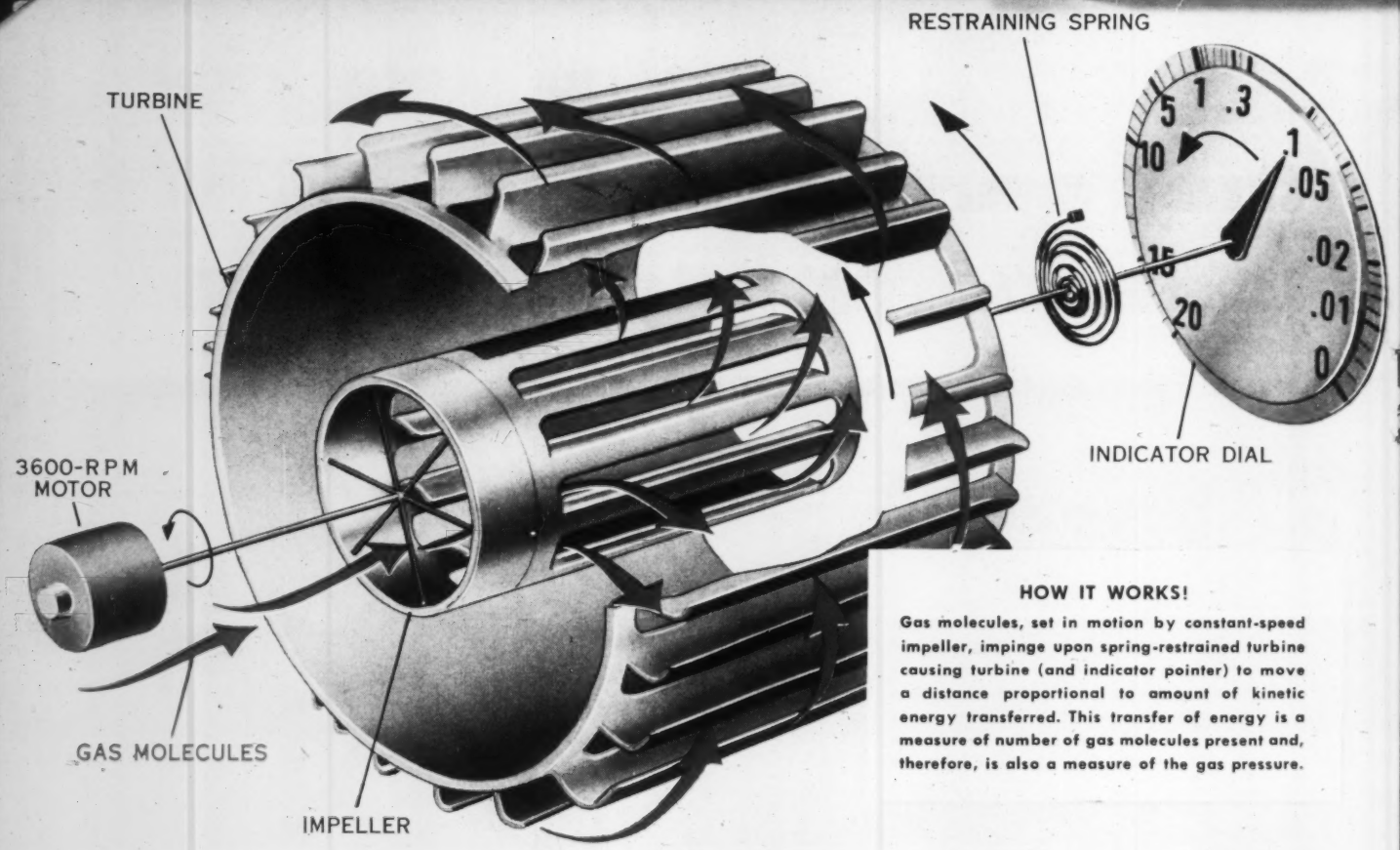
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **6** on inquiry card.



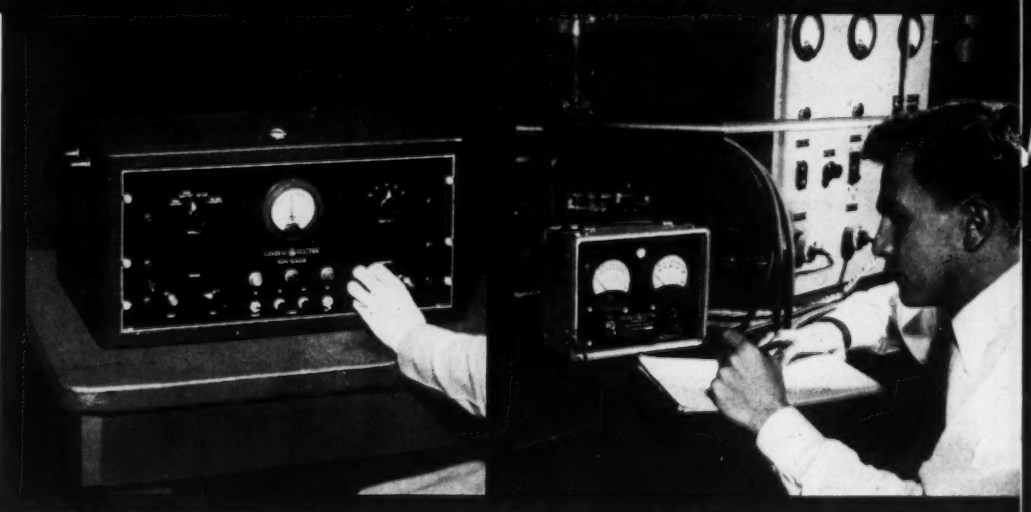
HOW IT WORKS!

Gas molecules, set in motion by constant-speed impeller, impinge upon spring-restrained turbine causing turbine (and indicator pointer) to move a distance proportional to amount of kinetic energy transferred. This transfer of energy is a measure of number of gas molecules present and, therefore, is also a measure of the gas pressure.

HIGHLY VERSATILE, the new G-E molecular vacuum gage is supplied with a scale for the direct reading of dry air (between 0 and 20 millimeters), or with a linear scale which may be easily calibrated for other gases. The device is therefore well suited for laboratory and research work in the fields of vacuum metallurgy and metal purification, outgassing of impregnates, distillation of low-boiling compounds, vacuum coating and plating, dehydration of heat-sensitive materials, and vacuum extraction and solvent recovery.

News About Other General Electric Equipment for Vacuum Systems

DETECTS FROM 1 TO 10^{-5} MICRONS **DETECTS FROM 1 TO 100 MICRONS**



ION VACUUM GAGE is easy to use and does not require continuous adjustment of the filament voltage supply. For longer life, the filament is automatically protected against excessive pressures. Price is $614.64*.

THERMOCOUPLE VACUUM GAGE eliminates the need for permanent test panels, lowers investment costs. This G-E instrument provides continuous, remote indication. The price is only $109.98*.

*Manufacturer's suggested retail price.

For more information circle **7** on inquiry card.

WITH THE G-E MOLECULAR VACUUM GAGE . . .

Measure Vacuum Without External Detectors

GENERAL ELECTRIC GAGE IS DIRECT READING FROM 1 TO 20,000 MICRONS

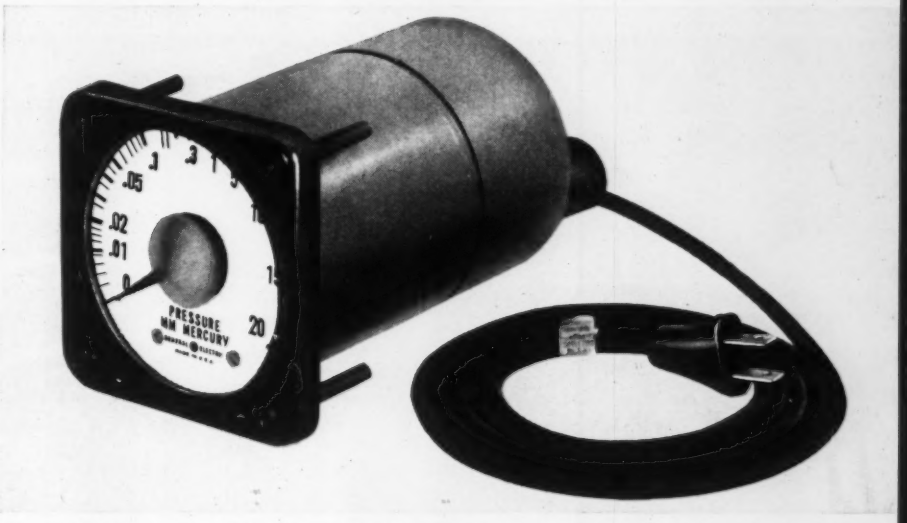
Because of its entirely new principle of operation, General Electric's molecular vacuum gage eliminates the need for external detectors. Now, you can measure pressure from 1 to 20,000 microns quicker and easier than ever before.

LOW IN COST, the G-E gage sells for only $195.00*. No other device costing as little offers the wide range and simplicity of operation provided by the molecular vacuum gage.

TUBE BURNOUTS ARE ELIMINATED because of the revolutionary new principle of operation used. The G-E gage is entirely mechanical. No electronic tubes or other electrical detecting devices are used.

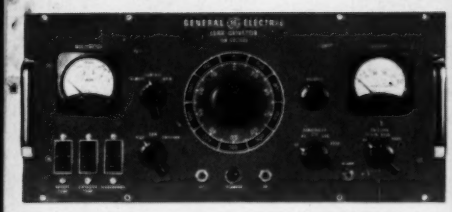
UNHARMED BY ATMOSPHERIC PRESSURE, the molecular vacuum gage may be opened without fear of damage to the mechanism. This feature is particularly valuable when semi-skilled personnel use the instrument.

FURTHER INFORMATION may be obtained by contacting your nearest G-E Apparatus Sales Office or check the coupon below for a copy of bulletin GEC-986.



EASY-TO-OPERATE, the molecular vacuum gage requires no complicated setting of control knobs. Direct-reading, the instrument calibration remains unaltered through continuous operation. The long scale span in the high-vacuum range, and the highly legible numerals of the indicator dial assure accurate readings. Face-plate studs facilitate panel mounting or the gage may be connected directly to the vacuum system plumbing.

EXTREMELY SENSITIVE LEAK DETECTION



SECTION A585-3
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Molecular Vacuum Gage (GEC-986)
- ☐ Ion Gage (HB-8282)
- ☐ Thermocouple Vacuum Gage (GEC-385)
- ☐ Type M-1 Leak Detector (GEC-336)

Name.....

Company.....

Street.....

City..... Zone..... State.....

G-E LEAK DETECTOR can detect a leak in vacuum or pressure systems at the rate of 5 x 10^{-7} standard cubic centimeters of air per second. Simple design of control panel makes this an easy instrument to operate. Compact mass spectrometer unit can detect leaks so small that more than 120 years would elapse before a thimble-full of air at atmospheric pressure could escape. Write for details.

GENERAL ELECTRIC

For more information circle **7** on inquiry card.

G-E PRECISION INDICATOR is available as a single-point or multiple-point instrument. For multi-point instruments different types of switches are available. The toggle type, pictured above, is either locking or non-locking, according to specifications. The push-button type remains in a depressed position until another button is pushed. The large easy-to-read scale supplies quick temperature readings for accurate records and makes logging a simple job for the operator. For further information contact your nearest G-E representative or send in coupon at the right.

USE G-E PYROMETERS FOR ACCURATE CONTROL

General Electric Pyrometers Give Dependable Protection

TYPE HP-3 PYROMETER, a two-position controller, has positive control action, initiated by 0.1 percent in full scale movement of instrument pointer. This gives accurate readings from easy-to-read 7-inch scale. Units are available for flush or surface mounting. Indicator, controller, and protector units are plug-in type, permitting easy servicing.

New G-E Precision Indicator Makes Temperature Checks Quick and Easy

New G-E Instrument Gives Finger-tip Scanning of up to 48 Process Temperatures in Helping You Maintain Accurate Product Control

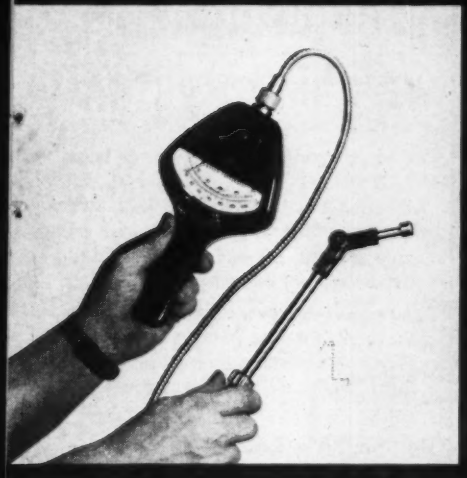
General Electric's new precision indicator scans, by manual switching, from 1 to 48 process temperatures on multi-installations of thermocouples or resistance-bulb circuits. The new G-E potentiometer features a wide temperature range scale and is a high-accuracy, null-balancing instrument.

NEW G-E INDICATOR assures you of having less maintenance by eliminating conventionally used dry cells, slidewire and sliding contacts. This excludes such time-consuming jobs as replacing dry cells, or cleaning moving contacts.

THE MAGNETIC STANDARD provides truly continuous standardization through a revolutionary measurement-circuit design, which incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control during standardization periods can never be experienced with constantly balancing G-E system.

G-E RECORDING CONTROLLER has same measurement-circuit design as precision indicator. Long term accuracy and precision of measurement are assured, and you get continuous dependable control with truly continuous standardization.

G-E HAND PYROMETER DESIGNED FOR WIDE USE



GENERAL ELECTRIC COMPANY
SECTION A587-1
SCHENECTADY 5, NEW YORK

Please send me a copy of the interesting and colorful bulletins checked below:

- ☐ GEA-6020 Hand Pyrometer
- ☐ GEC-713 Thermocouple and Accessories
- ☐ GEC-1311 Type Precision Indicator
- ☐ GED-2100 New Recording Controller

Name .....
Company .....
Street .....
City ..... Zone ..... State .....

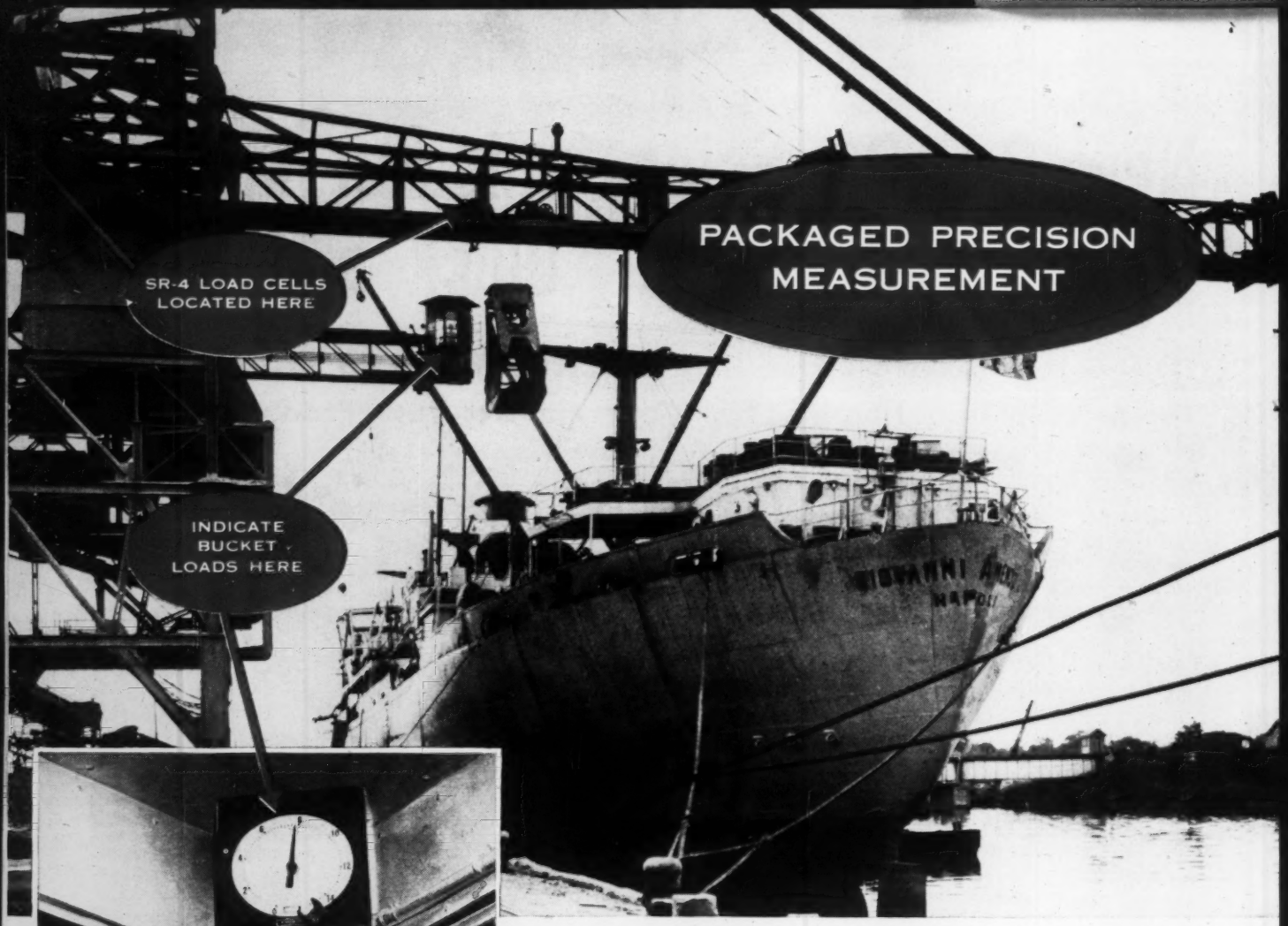
DUAL-RANGE General Electric hand pyrometer is designed for more flexible and inexpensive measurement of gas, surface and molten-metal temperatures.

EASY-TO-USE hand pyrometer accurately indicates temperature of precision castings. The instrument is light in weight with a non-slip, bayonet-grip handle.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle 8 on inquiry card.



Baldwin SR-4 System indicates and continuously totalizes ore loads in the crane cab (above). The operator has a continual check on the load being carried by the clamshell.

At Alabama State Docks this Heyl & Patterson crane...

unloads ore faster by using SR-4® automatic weighing system

Baldwin's "Packaged Precision Measurement" can cut your ore handling costs. That's been proved at the Alabama State Docks, Mobile, Alabama. There a Heyl & Patterson unloading crane is using Baldwin SR-4 load cells and recorder to weigh electrically clamshell buckets of ore.

This Baldwin SR-4 automatic weighing system benefits this user three ways:

1. **Faster handling:** The bucket does not have to be stopped to determine weight since its weight is being continuously measured by two 20,000 pound load cells in the sheave block. More ore can be handled by the unloading equipment each shift, reducing handling costs.
2. **Easy operation:** A large indicator dial in front of the operator tells him when to add the weight on the totalizing counter. The indicator totalized the weights measured by two distant SR-4 Load Cells and zeroes out all but net weight of ore.
3. **Low maintenance:** SR-4 Load Cells have no moving parts to wear out. They are sealed against air-borne dust They are giving accurate, dependable service.

Baldwin SR-4 Load Cells can solve your weighing and force-measuring problems. Write for our *new* Bulletin 4301. It's loaded with detailed information on typical applications and instrumentation for these unique devices. It tells you how to use them for local or remote indication, recording, signaling or process control. Use coupon today!

Department 3215
Baldwin-Lima-Hamilton Corp.
Philadelphia 42, Pa.
(In Canada: Peacock Bros., Ltd., Montreal, Quebec)

- ☐ #4301 (SR-4 Load Cells and Load Beams)
- ☐ #4304 (SR-4 Crane Scales)
- ☐ #4305 (SR-4 Platform and Track Scales)

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State ____

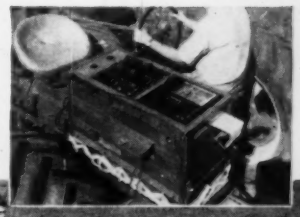
BALDWIN BLH LIMA-HAMILTON

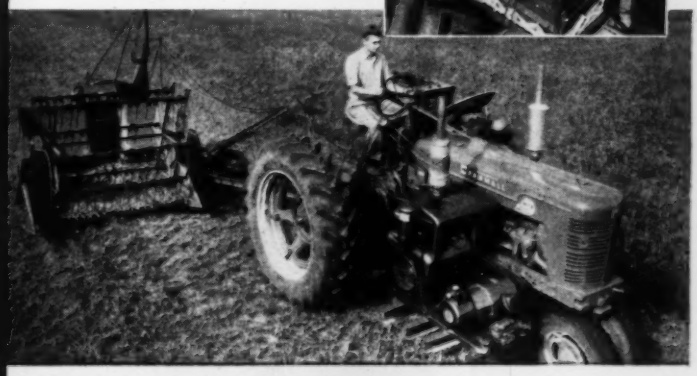
Eddystone Division
BALDWIN-LIMA-HAMILTON

For more information circle 9 on inquiry card.

. . . from field-testing harvesters to checking jet starter performance . . . SANBORN OSCILLOGRAPHIC RECORDING SYSTEMS prove their versatility

Research and Development





FOR INTERNATIONAL HARVESTER'S ENGINEERING TEST AND DEVELOPMENT DEPT.

A specially housed and shock-mounted Sanborn 2-channel recorder provides dynamic strain measurement data on a field forage harvesting machine, during actual field use. In the photographs, rotor shaft torque and RPM are being recorded, one of several uses International Harvester has found for the Sanborn System in field testing their farming equipment.

Production Testing

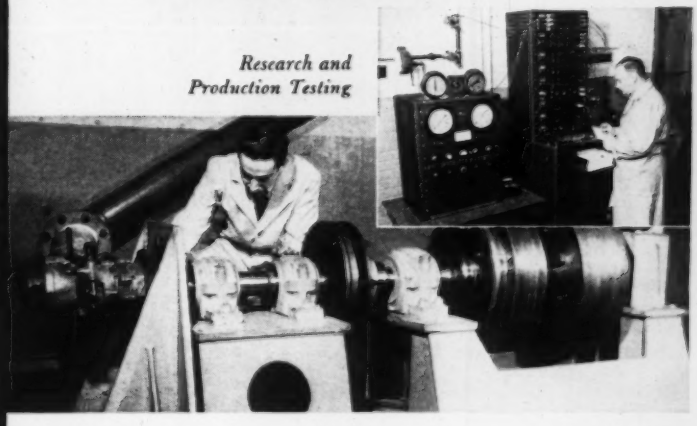
AT ARCH GEAR WORKS, QUINCY, MASS. . . .

A record of tooth regularity of various types of precision gears is obtained on a single-channel Sanborn Model 141 System, used in conjunction with a special gear checking instrument devised by Arch Gear Works. The equipment permits visual spot checking of gears, helps maintain a high rate of acceptability and provides a permanent record of tests often required by customers.

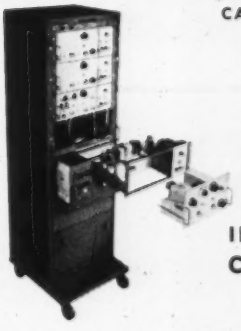
AT G. E.'S AIRCRAFT GAS TURBINE DIV. . . .

Engineers record performance data such as temperatures, pressure, RPM and starting time of jet engine starters, using a modified Sanborn Model 67 System. Six channels of information are recorded in this four-channel unit, equipped with three DC amplifiers, one Triplexer, a four-channel DC Converter, two-channel zero suppression network and two modified strain gage amplifiers. The data also provides G. E. engineers with an indication of the performance of all production units.

Research and Production Testing



These typical applications indicate the scope of usefulness of standard and modified Sanborn Recording Systems. Wherever accurate, permanent, graphic registration of electrical phenomena in the 0-100 cps range is required, the *versatility* and *flexibility* of Sanborn one-, two-, four-, six- and eight-channel systems will prove invaluable. A wide variety of readily interchangeable, plug-in preamplifiers enable *one* basic system to meet *many* recording requirements. Standard instrument features include inkless recording in true rectangular co-ordinates, high torque galvanometer movement, time and code marking, and a choice of nine chart speeds.



CATALOG AND TECHNICAL DATA AVAILABLE ON REQUEST

SANBORN COMPANY

INDUSTRIAL DIVISION

CAMBRIDGE 39, MASS.

For more information circle **10** on inquiry card.

NEW Advanced Design...

NEW HIGH SUSTAINED ACCURACY . . .
even under extreme operating and ambient conditions

NEW CONVENIENT ZERO ADJUSTMENT . . .
external—no need to remove weather-proof cover

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

d/p Cell Flow Transmitter...

NEW POSITIVE OVERRANGE PROTECTION . . . up to full 1500 lbs. cell rating

6 Major Achievements!

NEW FULLY ADJUSTABLE RANGE . . . from 0-50" to 0-250" H_2O differential

NEW AUTOMATIC INTERNAL DAMPING . . . fast, stable measurement

NEW SIMPLICITY . . . lowest cost installation

Pioneered by Foxboro 7 years ago, the d/p Cell* Transmitter established a new standard of performance in flow measurement and control. Over 40,000 are maintaining that standard in every branch of industry today. Technical advances, based on this unequalled experience, now have added even further reliability, economy and convenience. Call your Foxboro representative for a demonstration. Write for new Bulletin 13-11.

Reg. U. S. Pat. Off.

FOXBORO
REG U S PAT OFF

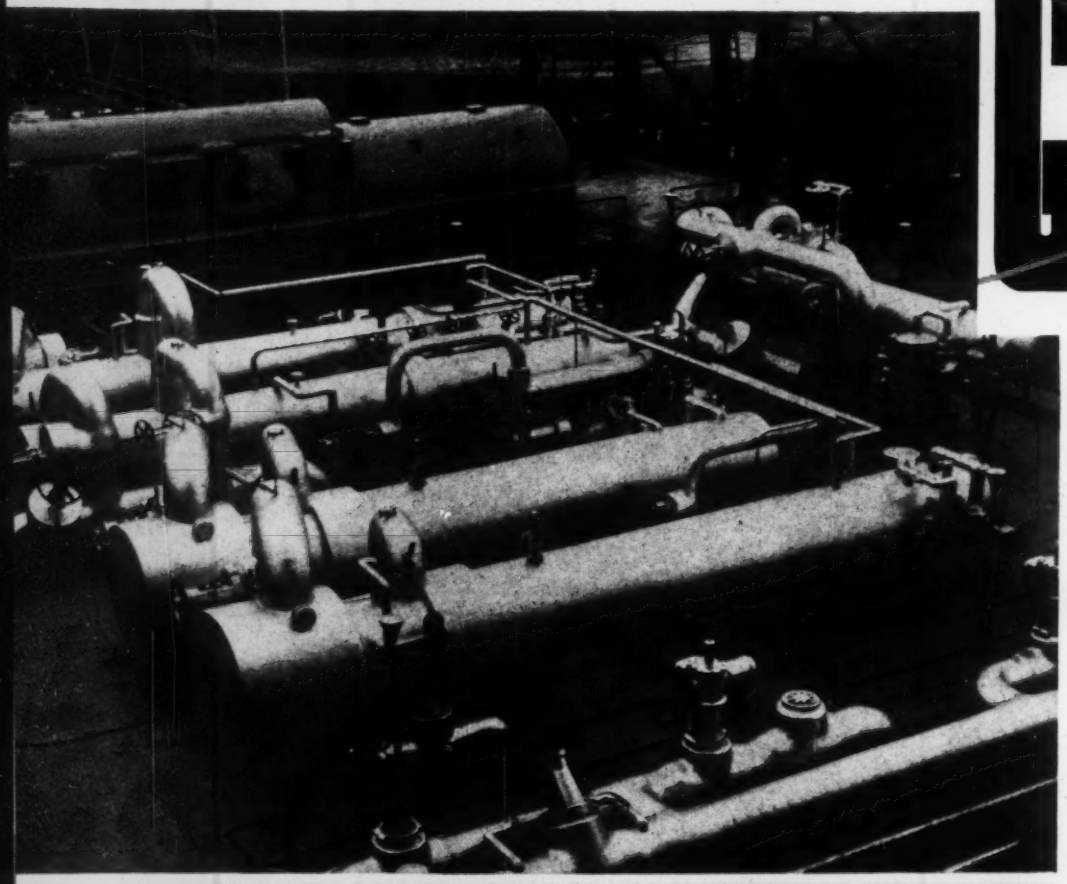
first in flow measurement

THE FOXBORO COMPANY, 465 NEPONSET AVE., FOXBORO, MASS., U.S.A.

For more information circle 11 on inquiry card.

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

GPE



Griscom-Russell feed water heaters in a 125,000 KW public-utility power station; save nearly 100 tons of coal per day. Heaters handle flow of water exceeding 2000 G.P.M. at 2500 pounds pressure and steam extracted from the turbine at five different points; "train" of five units pre-heats water fed to boilers from 90° F. to 441° F.

Askania multiple fuel boiler control panel in large steel plant; maintains metered proportion between combustion air and fuels—coke oven gas and fuel oil—for most economical combustion; holds steam pressure constant through all load changes and keeps furnace pressure at a safe and predetermined value.

General Precision Laboratory's Industrial TV Camera, the "Bullet"; portable, easily operated; used to monitor and improve manufacturing processes and to view hazardous industrial operations.

The highly advanced technological products designed and manufactured by the eighteen producing companies of General Precision Equipment Corporation serve more than a dozen major industries. Products of six of these GPE Companies—Griscom-Russell, Askania, Librascope, Link, Kearfott and General Precision Laboratory—have widespread application in the processing and power industries.

Industrial Processing...and Power

The Griscom-Russell Company is one of the country's largest producers in the fields of heat exchange and water distillation. It is the pioneer in heat exchanger equipment—the key to the whole complex of modern industrial processing and power. For over seventy years, G-R equipment has been responsible for greatly increased efficiency and lowered operating costs in industry.

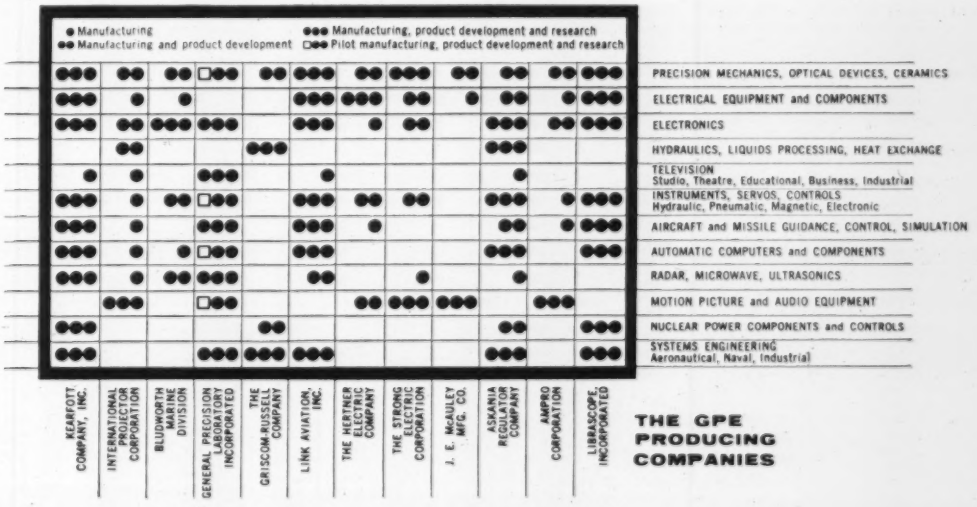
Askania Regulator Company for a quarter of a century has been a leading developer in the field of regulators and controls, including components and systems. Its products are widely used by the power, steel, gas and coke, mining, chemical, petroleum, glass and paper industries—wherever great reliability and accuracy are essential.

Kearfott Company, Inc.; Librascope, Incorporated; and Link Aviation, Inc. produce a wide variety of precision instruments, computers, servos and other control components for equipment and systems used throughout the power and the processing industries. Industrial television equipment manufactured by General Precision Laboratory Incorporated, the sixth GPE Company active in these fields, is playing increasingly important roles in "seeing eye" monitoring operations in these industries.

Each company in the GPE Group works in specific, highly specialized technical areas, as indicated in the chart below. Each of these companies, in addition to specializing in its particular products and fields of technical competence, has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation is achieved through GPE's basic operating policy, Coordinated Precision Technology.

In the fields of research and development, GPE Coordinated Precision Technology permits a high degree of specialization in particular areas of competence and supplements such specialization by the application of techniques in other fields, as desirable. In the field of production, it makes possible a highly flexible application of facilities. This policy has been responsible for a diversified line of precision equipment of superior design and performance, covering a wide range of both standard and special uses.

Perhaps the most conspicuous advantage of GPE Coordinated Precision Technology is that the concept and development of equipment, and of solutions to the underlying technical problems, are not restricted or distorted by traditional allegiance to specialization in a particular field. GPE coordination permits the engineers and technical personnel of each GPE Company to seek the optimum solution for the customer within the total capacities of the GPE Companies as a group.



A brochure relative to GPE Coordinated Precision Technology and the work of the GPE Companies is available. Address your request, or inquiries on specific problems, to:

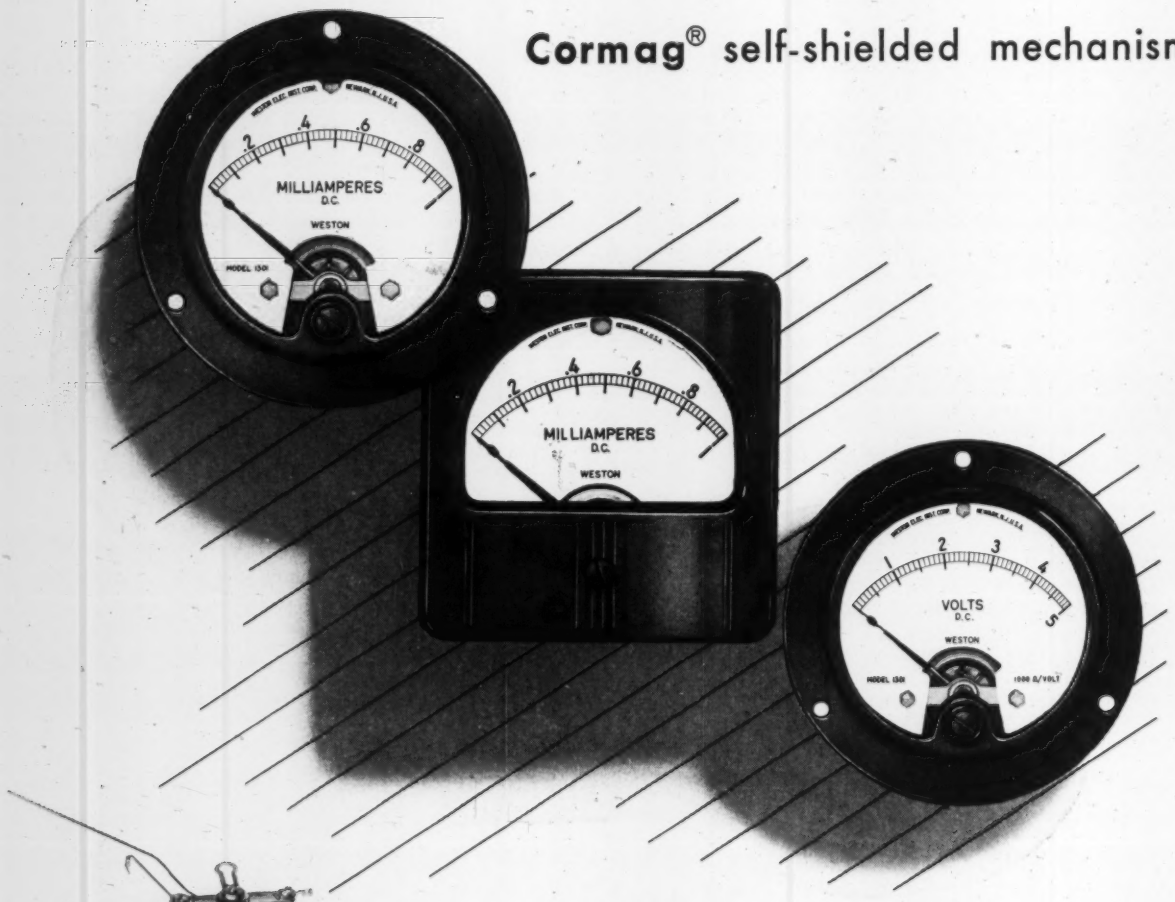
General Precision Equipment Corporation

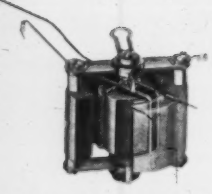
92 GOLD STREET, NEW YORK 38, NEW YORK

For more information circle **12** on inquiry card.

NEW in design concept...in dependability

Weston 1301 line panel instruments with Cormag® self-shielded mechanism





Weston CORMAG® Mechanism (shown in combination cutaway and phantom)

A compact, lightweight permanent magnet moving-coil mechanism, self-shielded from the effects of external magnetic fields.

The 1301 line (3½") furnishes panel instrument users with the added dependability, the mounting facility, and the new economy which CORMAG self-shielded construction provides. These instruments can be mounted on magnetic or nonmagnetic panels interchangeably, and there is no magnetic intereffect of instruments on one another when mounted in close proximity. For complete information, see your local WESTON representative or write... WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

WESTON instruments

For more information circle **13** on inquiry card.

Your problem in Electronic Systems Design

A major problem in electronic controls systems design is how to get information into and out of machines, because machines, like people, do not always speak the same language. Thus devices must be created solely to convey information between machines. A good example of this is the Librascope-designed analog-digital converter which translates mechanical motion into electronic codes. Other Librascope devices provide similar avenues of information, making it possible to communicate with machines, processes, and understand heretofore unintelligible phenomena. Librascope components are packaged in sub-assemblies which are then combined into control and data-handling systems for commercial and military projects. These devices can also be assembled into a myriad of different configurations, many of which may be applicable to your particular problems. Write today for details.

Librascope also manufactures mechanical and optical control devices and computers. Send for booklet describing our company.

Engineers in search of interesting assignments, security, advancement—contact Mac McKeague, Personnel Director.

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. • 808 WESTERN AVENUE • GLENDALE • CALIFORNIA

For more information circle **14** on inquiry card.

CRESCENT

POLYETHYLENE

MULTITUBE

For Economy with Lasting Dependability in your Instrument Tubing Problems

CRESCENT POLYETHYLENE MULTITUBE is composed of 2 to 19, 1/4" O. D. Polyethylene tubes up to 1000 feet in length, ***spirally cabled together*** to allow bending with a short radius without distortion of the tubes. The tubing assemblies are protected by a flexible interlocked galvanized steel armor (Type PA), or by a tough corrosion-resistant thermoplastic sheath (Type PT). Tubes are furnished in seven contrasting colors for ready identification of each tube at both ends.

TYPE PA—The galvanized steel armor provides complete protection from injury during and after installation. In the event of fire, the molten Polyethylene is retained within the armor.

TYPE PT—The polyvinyl chloride thermoplastic sheath provides good mechanical resistance, with complete corrosion resistance, and it is flame retarding.

Economy is achieved in the initial cost of **CRESCENT POLYETHYLENE MULTITUBE** and its accessories, as well as in substantial savings in labor costs of installation. Moderate to long length runs of light weight and compact **MULTITUBE** assemblies result in fewer connections and fittings, lower cost for supports or racks, ease of mounting, less space being used.

CRESCENT POLYETHYLENE MULTITUBE can be pulled through conduit or raceways.

TYPE—PA

TYPE—PT
1/4" OD Tubes

Send for Bulletin giving complete information and engineering data

CRESCENT

INSULATED WIRE & CABLE CO.

OLDEN & TAYLOR STS., TRENTON, NEW JERSEY

For more information circle **15** on inquiry card.

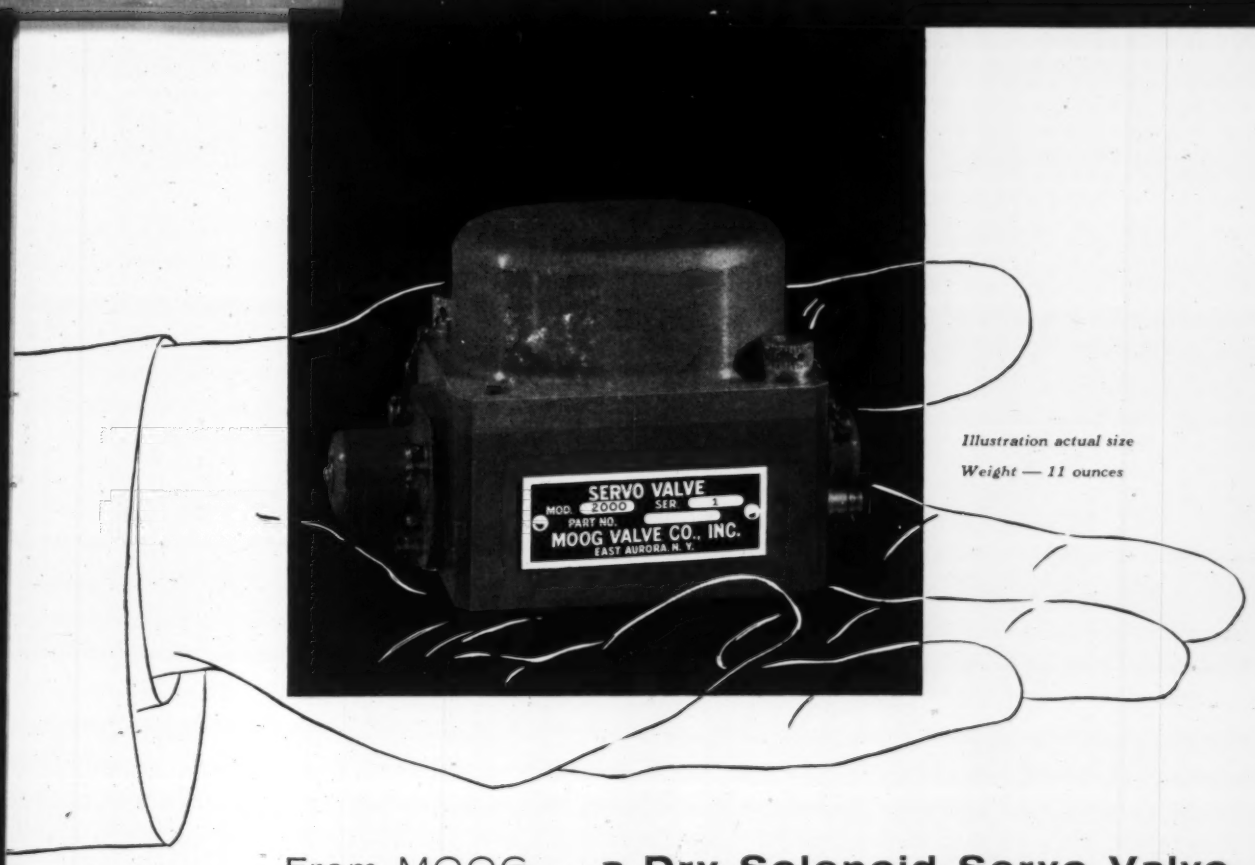


Illustration actual size

Weight — 11 ounces

From MOOG . . . **a Dry Solenoid Servo Valve**

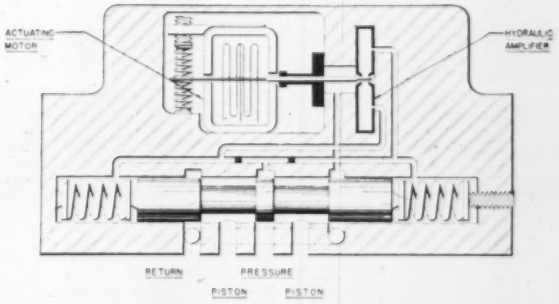
For those electro-hydraulic servo systems which require valves of high dynamic performance, reliability, small size and low weight, Moog units have achieved recognition as the industry standard.

And now, for those systems in which the fluid contains entrained iron, Moog has developed the Model 2000 Servo Valve. These units feature a dry solenoid which eliminates the possibility of torque motor contamination due to magnetic particles. These valves comply with requirements of MIL-H-5440A and are smaller and lighter than other Moog units of the same flow capacity.

Moog Valves, including Model 2000, are proportional type, electrically actuated, hydraulic, four-way valves featuring high dynamic response, sensitivity, linearity, and reliability. Production models are designed to operate in hydraulic systems of from 1000 to 3000 psi pressure. Rated output flows from 0.1 to 50.0 GPM for control currents of from 2.0 to 40.0 milliamperes as specified are available in production units.

Conventionally the valve input is from a balanced push-pull DC amplifier and the valve flow output is applied to a piston or hydraulic motor. An electric signal proportional to piston position or motor angular rotation is fed back to the amplifier to give a closed servo loop.

Typical applications for these units are in servo systems used for guided missile and aircraft flight controls, radar scanner actuation, contour following machine tools, and automatic packaging equipment.



For details write for Bulletin 2000-3

MOOG VALVE CO., INC. PRONER AIRPORT EAST AURORA, N. Y.

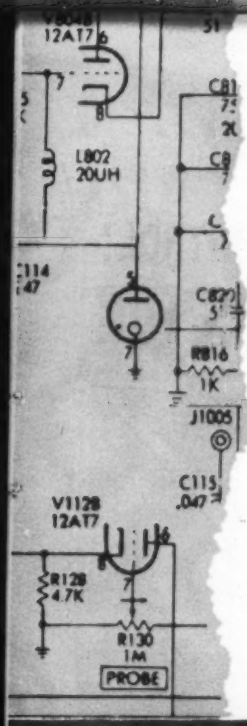
For more information circle **16** on inquiry card.

Byron Jackson Co.

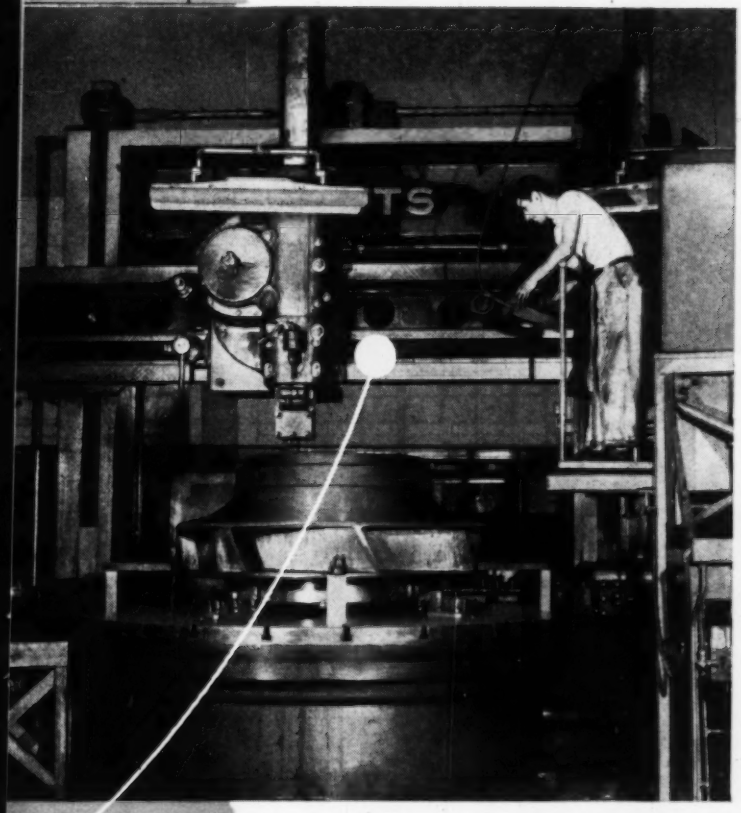
and

The Rollin Co.

combine



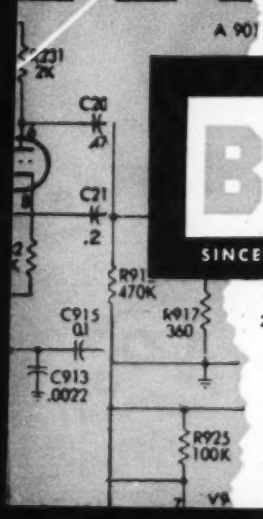
Now electronic ingenuity combined with **heavy industrial facilities**



Experienced electronic engineering . . . backed by diversified heavy industrial facilities . . . gives the Byron Jackson Co. Electronic Division an unusual ability to pioneer precision electronics in practical form.

The engineering nucleus of this Electronic Division has, since 1944, been engaged in the development and manufacture of high power signal generators, precision slotted lines, miniature digital type transducers, and other precision electronic equipment. Now these electronic skills are teamed with the metallurgical, hydraulic, mechanical, chemical, nuclear, electrical and petroleum specialists and scientists of Byron Jackson Co. In addition, a multi-million dollar investment in plants and production equipment supports our specialized electronic manufacturing and testing facilities.

This unique combination of engineering talent and production abilities is ready to work for you in the field of measuring and testing instruments, complete systems, or an entire development production project.



BJ
SINCE 1872

Byron Jackson Co.

ELECTRONIC DIVISION

2010 LINCOLN AVENUE, PASADENA 3, CALIFORNIA • TELEPHONE: RYAN 1-7134

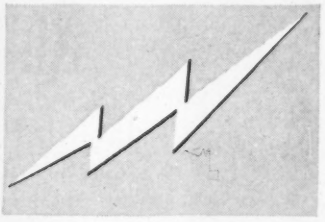
For more information circle 17 on inquiry card.

NEWS IN TEMPERATURE MEASUREMENT AND CONTROL!

HAGAN MODEL "P" AMPLIFIER SETS NEW RECORDS FOR

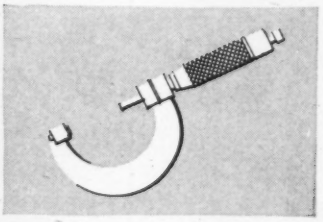
SPEED

FULL SCALE RESPONSE IN 0.1 SECOND



ACCURACY

PLUS OR MINUS ¼% OF INPUT RANGE

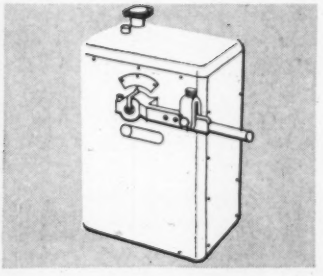


LOW MAINTENANCE

NO SLIDE WIRES — NO REVERSING MOTORS

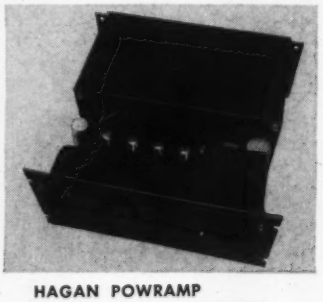
CONTROL

WITH HAGAN ELECTRO-PNEUMATIC CONVERTER



The new Hagan Model "P" DC Amplifier is a key instrument in the new and advanced PowrAmp line of electro-pneumatic and electro-hydraulic measurement and control components with unusual sensitivity and accuracy. It may be used with any of the following primary inputs: Thermocouples, Thermistors, Radiation Pyrometers, DC Strain Gages, Resistance Thermometers, Pressure Pick-Ups, and many other low voltage DC inputs. Check these many features of this remarkable new instrument:

Measurement continuous—no slide wires and motors • Broad frequency response—flat to 10 cps • Unsuppressed instruments—no standardization necessary • Flexible voltage and double current outputs • Steady calibration—long time measurement accuracy—feedback stabilized • Fixed or adjustable zero suppression with remote zero suppression available • Multiple ranges



HAGAN POWRAMP MODEL "P" DC AMPLIFIER

Send for Hagan Bulletin MSP-111.1 for the full story on the flexibility and range of application of this versatile instrument.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

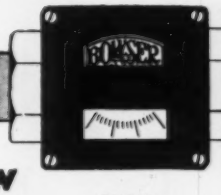
Control Systems for Aeronautical and Automotive Testing Facilities • Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems

For more information circle **18** on inquiry card.

BOWSER
ESTABLISHED 1885

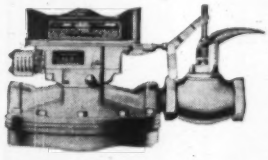
Automated

liquid handling is not new

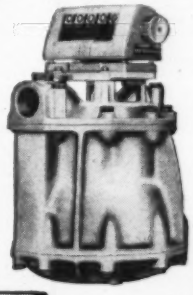


FLOW INDICATORS AND CONTROLS

Bowser's many years of experience are yours when you consider improved liquid-handling facilities for your operation. Here are examples of equipment applicable for automatic processing or production of industrial liquids . . . perhaps your product . . .



Optional repeating meter dial delivers predetermined quantities automatically.



Optional recording printer mounts on meter. Prints quantity of liquid metered.

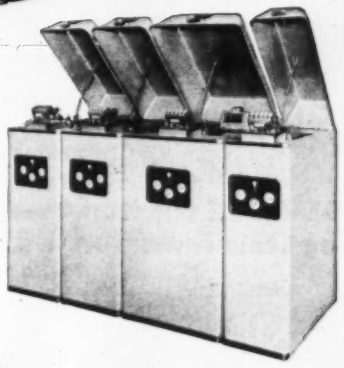
XACTO METERS

There is a Bowser Meter for nearly every product and application. Xacto Meters are standard in most industries. Broad capacity range. Choice of many dials and metal construction. Only a few are shown at left.

FILTERS

EXPENDABLE CARTRIDGE TYPE

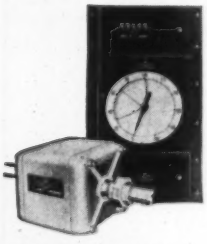
A wide range of Bowser filters and dehydrators is available for both oil and aqueous liquids in batch and continuous operations. Cartridge-type for oils is shown at left.



BLENDING SYSTEM

Accurately blends two or more liquids in desired proportions for continuous or intermittent line production. Each ingredient is metered and recorded for uniformity in closed, piped system. Blends oils, beverages, chemicals, liquid foods, etc.

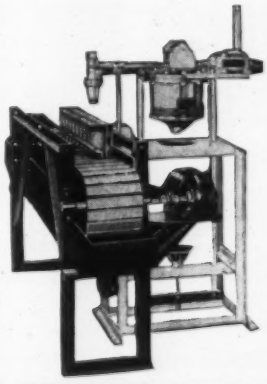
ELECTROMAGNETIC METERS



HANDLES CONDUCTIVE LIQUIDS WITH SOLIDS ENTRAINED

The Bowser "Xactronic" provides straight-line metering for conductive liquids, slurries, acids, etc., except oils. High-pressure or suspended solids are no obstacle. Exposed parts are Teflon and stainless steel.

PACKAGING UNITS



Available in many capacities. Electric or manual control. May be set for any quantity. Temperature and specific gravity adjustment dials provide greatest possible accuracy. Widely used for can and barrel filling. With or less conveyor.

CHECK ITEMS OF INTEREST BELOW AND MAIL COUPON FOR LITERATURE

XACTO METERS FOR INDUSTRIAL LIQUIDS ☐

BLENDING SYSTEMS FOR PRODUCTION ☐

PACKAGING UNITS FOR LIQUID PRODUCT ☐

INDUSTRIAL LIQUID FILTERS ☐

ELECTROMAGNETIC METERS ☐

DATE_____

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

PRINCIPAL LIQUIDS_____

BOWSER, INC., FORT WAYNE, IND.
1367 E. CREIGHTON AVE.

For more information circle **19** on inquiry card.

for improved readability, specify the new

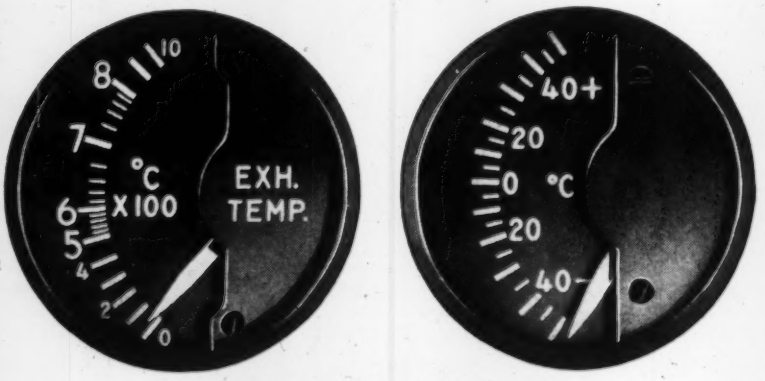
LEWIS

LONG SCALE

aircraft temperature indicators

- Standard AND10412 cases
- Scale arc approximately 250°
- No auxiliary components
- No vacuum tubes
- Operate the same as conventional thermocouple type or resistance type temperature indicators
- Interchangeable with conventional temperature indicators, use standard resistance bulbs or thermocouples and leads
- Made to Military Standard Specifications
- Tested and Approved

COMPARE the improved readability of these long scale indicators with these . . .



Conventional indicators

Recognizing the need for improved readability without increasing panel space requirements, The Lewis Engineering Company has developed these completely new Aircraft Temperature Indicators both in the Thermocouple Thermometer type and in the Resistance Thermometer type.

the LEWIS ENGINEERING COMPANY

naugatuck, connecticut

For more information circle **20** on inquiry card.

Trends...

INSTRUMENTS and AUTOMATION

European efforts in nuclear power may exceed ours. Both Russia and England are already using reactor heat for heating and power. Britain has announced spectacular program for nuclear power—12 nuclear power plants within 10 years. Scientists in Norway, France, Sweden, and Netherlands, in addition to those in England and Russia are boldly making progress. First International Conference in U.N. on peacetime use of atomic energy opens in Geneva on Aug. 8. International cooperation will have mutual benefits—all nations now have knowledge to trade off. Nuclear instrument industry will benefit from this trend.

Public water supplies is expanding field—because of 4% annual increase in water plus 2.5% annual increase in population served by such supplies. Instrumentation of each supply also is growing; new $250,000 filtration plant for McAlester, Okla., adding 3 million gallons to city's capacity, has $32,000 remote-control pneumatic monitoring system (Minneapolis-Honeywell).

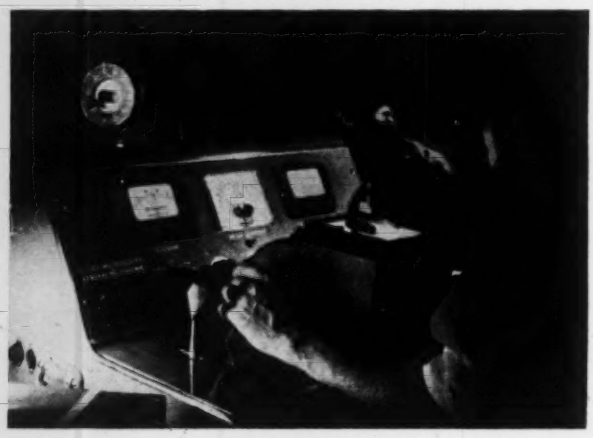
Computers and high-speed data-processing machines are opening new instrumentation era. Recognition is growing on part of industrial engineers and business men that new and promising fields are being opened. General Electric Co., which started to use digital computers eight years ago, now uses them for more than 200 different projects. Joint undertaking by Minneapolis-Honeywell and Raytheon to market data-processing systems via new Datamatic Corporation brings process and computing fields closer.

Generalizations by speakers, writers, and editors about manless push-button plants have now alarmed all segments of our economy. Latest development: Senator O'Mahoney at recent CIO conference on automation announces he will investigate automation (see editorial on page 723).

Highlights of an expanding industry: Fairchild C&I begins construction of new 24,000-sq-ft plant on West Coast; Robertshaw-Fulton Controls opens new $3 million Grayson Controls Div. plant at Long Beach Freeway, Calif.; Norden-Ketay leases 20,000-sq-ft plant in N.Y. city; Beckman Instruments acquires Specialized Instruments Corp. and Spinco Service Co., both of Belmont, Calif.; Fisher Governor Co. has purchased 17,250-sq-ft factory in Ontario, Canada; Daystrom, Inc., has acquired controlling interest in Weston Electrical Instrument Co., Panellit has bought Jordan Electronic Mfg. of Pasadena; International Resistance Co. has bought Hycor Co. of Calif.; Hycon Mfg. has purchased 67 acres of industrial property at LaVerne, Calif.; Sunshine Scientific Instrument of Phila. has purchased all rights to 18 instruments developed by GE; Cannon Electric has plans for new 30,000-sq-ft building in Los Angeles; ElectroData Corp. of CEC announces plans for new 40,000-sq-ft plant in Pasadena; Gyromechanisms has expanded its facilities by 20%; Topp Industries has purchased Standard Electronic Mfg. of Culver City, Calif.; Automatic Temperature Control Co. of Phila. has been acquired by The Safety Car Heating and Lighting Co. of New Haven, Conn.; Remington Rand and Sperry Gyroscope announce merger plans.

X-ray Microscope

SCHENECTADY, N.Y.—Sterling Newberry, General Electric development engineer, is shown at the controls of the company's new X-ray Microscope, which can "look



inside" specimens invisible to the human eye. The instrument reveals the grain structure of metals, the internal organs of insects, and inner details of other microscopic subjects through which light cannot pass. Sharp images result from the X-ray source, which is only 10^{-5} inch in diameter. Electronic magnification of the image permits direct viewing.

First of its kind in the U.S., the device was developed by the General Engineering Laboratory, Schenectady. It will be produced in quantity by the firm's X-ray Department in Milwaukee, Wisc., after further refinements are made in the design.

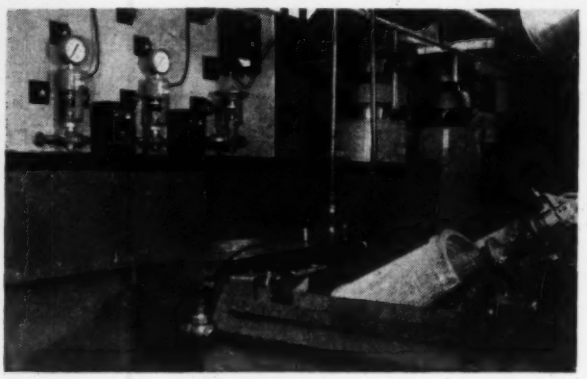
Centralized Traffic Control

NEW YORK, N.Y.—Col. Sydney H. Bingham (right), Executive Director and General Manager of the New York Transit Authority explains a model of the new Centralized Traffic Control Machine System which the Union Switch & Signal Division of Westinghouse Air Brake Company is installing to provide push-button control for the entire IRT subway system of train movements and signals. Viewing the model of the master control unit which the entire IRT will eventually use is Edward

O. Boshell, Chairman and President of Westinghouse Air Brake. An annual operating saving of $3,000,000 combined with speedier and more efficient IRT train service is expected when the push-button Centralized Traffic Control System spans the entire IRT system. The new system will permit 11- instead of 9-car trains, and safer movement at minimum intervals and maximum speeds.

Automatic Rinse Water Control

NEW YORK, N.Y.—Greatly reduced water consumption with increased electroplating quality resulted from this installation of the "Solu Bridge" automatic rinse-tank



controller, (developed by Industrial Instruments Inc., of Cedar Grove, N.J.) at Spectranome, W. 13 St., New York, N.Y. The "Solu Bridge" rinse-tank controller operates by continuous measurement of the degree of electrolytic conductivity of rinsing waters. Automatic control of the amount of fresh water admitted into rinse tanks is thus permanently established.

High-power Transistors

FORT MONMOUTH, N. J.—New high-power transistors show promise of being able to handle sufficient power to eventually replace high-power vacuum tubes. The transistors, developed under Signal Corps sponsorship by Transistor Products, Inc., a Clevite Corporation unit in Waltham, Mass., were tested at the Signal Corps Engineering Laboratory, Fort Monmouth, N. J.

AEC Reactor School

WASHINGTON, D.C.—Lewis L. Strauss, Chairman of the U.S. Atomic Energy Commission, announced that enrollment has been completed for the new School of Nuclear Science and Engineering, one of the major projects undertaken by the AEC in cooperation with the State Department and the Foreign Operations Administration in support of the President's atoms-for-peace program.

There will be 31 scientists and engineers from 19 nations representing a cross section of applicants from Europe, Central and South America, the Near, Middle

NEW HIGH VOLTAGE SILICON JUNCTION DIODES

NEWLY EXPANDED TI LINE NOW INCLUDES 15 SINGLE CRYSTAL JUNCTION TYPES IN 20% VOLTAGE RANGES FROM 4.7 TO 470 VOLTS!

high temperature conditions call for silicon diodes from Texas Instruments — your most experienced source of supply for silicon semiconductor devices. The first commercial producer of silicon transistors, TI has produced for commercial and military use many thousands of silicon junction diodes and triodes. TI now introduces a completely new line of silicon diodes including many high voltage types, greatly increasing the application for these reliable devices. This new line features types with characteristics stable to 150°C.

TI

low back current, another important characteristic of TI silicon junction diodes, opens up still more space and weight saving circuit design possibilities. With back current as low as 0.001 microamp at rated voltage for many types, these silicon junction diodes can be used in applications where high operating temperatures and low back current requirements make germanium diodes unsuitable.

100 per cent inspection and aging of every TI diode assures maximum reliability. Thoroughly tested at high temperatures, these uniformly high quality silicon diodes will increase electronic equipment dependability where heat, shock and vibration are problems. Every unit is hermetically sealed, providing maximum protection against ambient moisture.

					Maximum Ratings at 25°C			Maximum Ratings at Elevated Temperatures				Typical Capacity μμfd f = 500 kc Temp. = 25°C Rev. Volts −12V†
TI Type	Max. Rev. Working Voltage	‡Min. Junct. Breakdown Voltage	Minimum Forward Current 25° Ma.	Volts	*Reverse Current Microamps	Dissipation mw	Average Rectified Forward Current ma	Ambient Temp. °C	*Reverse Current Microamps	Dissipation mw	Average Rectified Forward Current ma	
600C	—	30.0	3	1	8@−10V	100	25	100	20@−10V	40	15	2.5
601C	—	50.0	3	1	0.04@−10V	100	25	150	40@−10V	20	10	2.5
604C	4.7	5.5	60	1	0.1	150	100	150	50	40	40	20
606C	6.8	7.5	35	1	0.1	150	90	150	50	40	35	16
608C	10.0	11.0	25	1	0.1	125	75	150	50	20	25	12
610C	15.0	17.0	12	1	0.1	125	60	150	50	20	20	7
612C	22.0	25.0	7	1	0.1	125	50	150	50	20	20	5
614C	33.0	37.0	5	1	0.1	125	35	150	50	20	15	3.5
616C	47.0	52.0	3	1	0.2	100	30	125	40	20	15	2.5
618C	68.0	75.0	1.5	1	0.2	100	25	125	40	20	10	2.0
620C	100.0	110.0	0.9	1	0.2	100	20	125	40	20	8	1.4
622C	150.0	170.0	6.5	4	0.2	90	15	100	30	30	5	1.2
624C	220.0	250.0	3	4	0.4	80	10	71	20	40	5	1.0
626C	330.0	370.0	2	4	1.0	75	7	71	20	30	4	0.9
628C	470.0	520.0	1	4	1.0	70	5	71	20	20	3	0.7

* At maximum working voltage except for types 600C and 601C.

† On types 604C, 606C, and 608C reverse voltage was reduced below breakdown voltage.

‡ Measured at 0.1 ma. Current increases rapidly above this point.

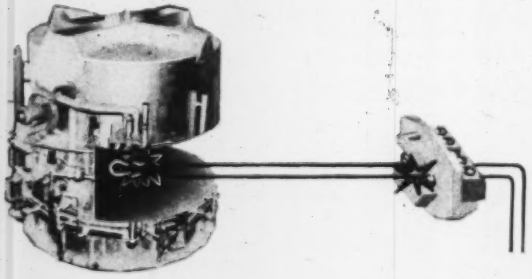
TWENTY-FIFTH YEAR OF PLANNED GROWTH

For detailed information about TI's complete line of silicon junction diodes, write for Bulletin No. DL-S 431.

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **21** on inquiry card.

2 SECONDS FOR THERMOCOUPLE CIRCUIT REPAIR



PEERLESS RESTORER®

Corroded, oil-soaked or dirty contacts in thermocouple circuits cause incorrect temperature readings, even with the most modern electronic pyrometers. The Peerless Restorer* detects and corrects these faults and re-fuses cracked or broken thermocouple tips **during the heat.** Your pyrometer trace records these corrected faults. This speeds permanent thermocouple circuit repair after the heat.

Pushing a button on your instrument panel insures proper circuit conductivity and accurate control of heat treating temperatures. Automatic Restorer models monitor thermocouple circuits without supervision.

Cut thermocouple circuit maintenance costs. Stop using and replacing extra "insurance" couples. Save time locating thermocouple circuit troubles. The Restorer operation is simple, safe and convenient.

One Restorer checks couples on many of your furnaces.

*Reg. U. S. Pat. Off.

Peerless® Electric

Send for Catalog R-22

ELECTRONICS DIVISION

THE PEERLESS ELECTRIC COMPANY

FANS • BLOWERS • MOTORS • ELECTRONIC EQUIPMENT

W. MARKET ST. • WARREN, OHIO

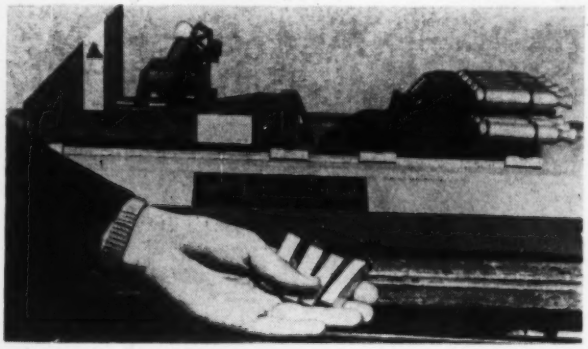
For more information circle **22** on inquiry card.

and Far East, among the initial enrollees. There also will be nine U.S. students in the class of 40. The School of Nuclear Science and Engineering will be located at the Argonne National Laboratory near Chicago, which is operated for the Commission by the University of Chicago. Dr. Norman Hilberry, Deputy Director of the Laboratory, will be the head of the school, which will have a fulltime faculty and be provided with its own laboratory facilities.

The seven-month session will include unclassified courses in design, construction, and operation of reactors for nuclear research; principles of design of nuclear power reactors; handling of irradiated materials and other related peacetime applications of nuclear energy.

Deceleration Tests

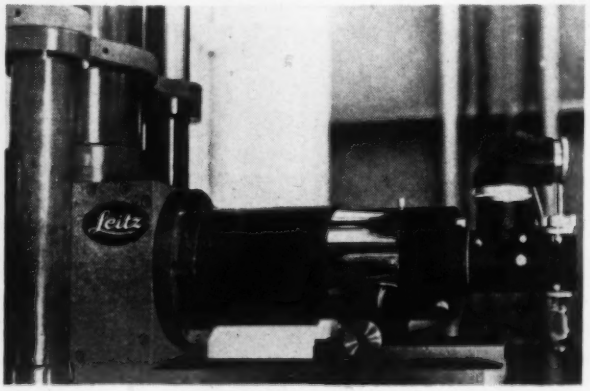
LOS ANGELES, CALIF.—High-speed deceleration sled tests in the recent U. S. Air Force Abrupt Acceleration Vehicle Project registered the crushing g forces with



Statham "Model F" accelerometers. Four of the miniature accelerometers were employed during the series of tests, conducted by Air Research and Development Command scientists at Holloman Air Force Base, in which g forces as high as 100 g on dummy subjects have been attained. The run, in which Lieut. Col. John Paul Stapp attained a speed of 632 miles per hour, resulted in his withstanding a peak of 40 g, with an average of approximately 25 g.

Radioactive Specimens Photographed in 3-D

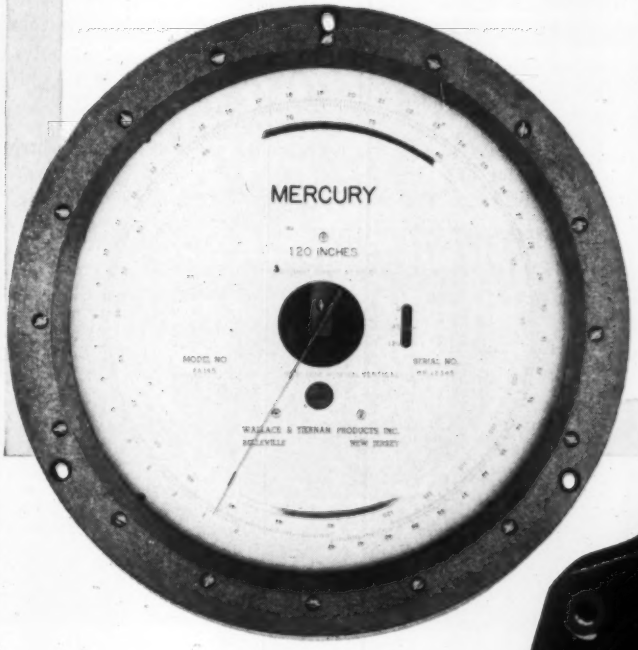
NEW YORK, N.Y.—Atomic scientists can now see and photograph radioactive specimens in 3-D. Shown is a side view of the lower section of a new stereoscopic viewing system designed by E. Leitz, Inc., 468 Fourth Ave., N. Y. N.Y., for the A.E.C.'s Knolls Atomic Power Laboratory,



PRECISION PRESSURE MEASUREMENT

of Gauge Pressure, Vacuum or Differential Pressure

Precision Dial Manometer Type FA-145



Accuracy:
1 part in 1000 over full scale.
Sensitivity:
1 part in 10,000 in *all* ranges.
Ranges:
0 to 120 inches of water (min.)
0 to 250 inches of mercury (max.)
Other intermediate ranges available.
Scale Length:
45 inches.
Dial Diameter:
8½ inches.

Precision Low Pressure Gauge Type FA-141

Accuracy:
1 part in 300 over full scale.
Sensitivity:
1 part in 500 in *all* ranges.
Ranges:
0 to 10 inches of water (min.)
0 to 400 inches of water (max.)
Other intermediate ranges available.
Scale Length:
7 or 16 inches.
Dial Diameter:
2¾ or 6 inches.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST., BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

For additional data, write for Publication TP-30-A and TP-27-A

A-101

For more information circle **23** on inquiry card.

BORG MICRODIAL

DIRECT READING THROUGH 3600° TO A DIGITAL ACCURACY OF 1 PART IN 1000.

FITS ANY MULTI-TURN DEVICE HAND OR SERVO OPERATED

The new direct reading Borg Microdial Model 1301 practically eliminates human error because it was designed for forced fast reading. Laboratory, production and processing controls become more accurate when clear, sharp, figures on the specially designed Borg Counter are observed through the focal-point window. Borg Counter figures are seen against a dull black background to provide maximum contrast for instant perception under difficult reading conditions.

The specially designed Borg Counter in the Model 1301 Borg Microdial reads from 000 to 999 to 000 in 3600 degrees of continuous rotation with no stops. Maximum recommended operating speed is 10,000 counts per minute (100 rpm).

Designed for military application, it has a built-in dust shield and clear-vision, wide-angle window for accurate reading from almost any position in front of the dial.

The Model 1301 Borg Microdial is compact. It measures only 1-3/4″ in diameter and 1-5/8″ in height and occupies no more panel space than the Micropot it controls.

WRITE FOR CATALOG SHEET BED-A31

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

For more information circle **24** on inquiry card.

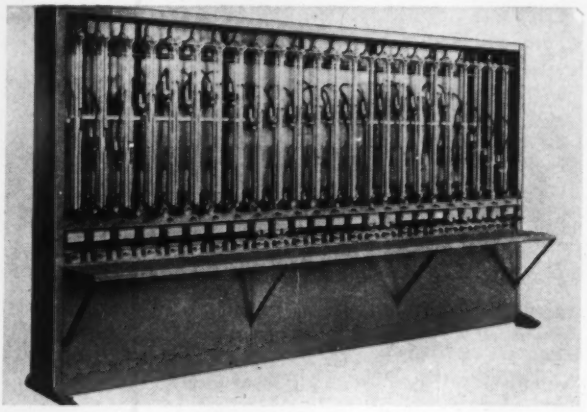
which is operated by the General Electric Company. The system permits scientists to see and photograph specimens in three dimensions. On the right end is seen a specially adapted Leica "72" camera with reflex attachment.

Lear Autopilots in F-84F

SANTA MONICA, CALIF.—A $3,000,000 Air Force contract has been awarded to Lear, Inc., for an initial quantity of a new Lear autopilot (type MB-2) by the Air Force, for Republic F-84F Thunderstreak jet fighters, according to an announcement by R. M. Mock, Lear president. The new MB-2 provides close altitude and flight control performance. A cross-feed system for yaw and roll signals automatically coordinates rudder and ailerons at all times.

Multiple L-P Manometer

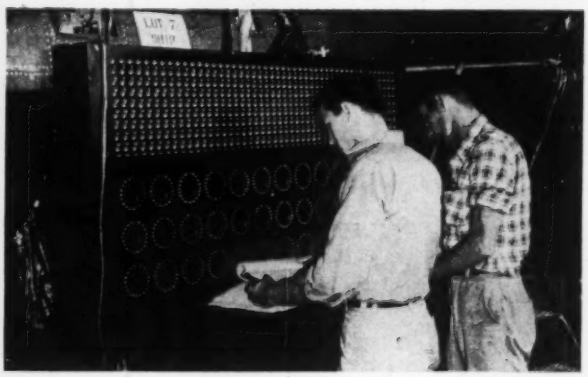
CHEYENNE, WYO.—A special 24-unit low-pressure manometer has been built for the General Electric Company by Ideal Laboratories, Inc., Cheyenne, Wyoming.



The instrument comprises 24 manometers and micro-readers, with flowmeters and shut-off valves. It gives 24 simultaneous pressure readings of absolute pressures (0 to 775 mm Hg) or differential pressures. Least reading of vernier for each scale is 0.001 inch.

Circuit Tester

DALLAS, TEXAS.—A compact panel with 423 lights and 641 switch positions has been developed to check electrical circuit continuity in the Navy Chance-Vought guided-missile Regulus. The maze of electrical circuits in



Complete coverage,

highest quality,

outstanding value

OSCILLATORS

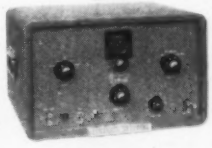
0.008 cps to 10 MC

Hewlett-Packard, pioneer of the now-standard resistance capacity or RC oscillator circuit, today offers 11 stable, wide range, RC oscillators covering all frequencies 0.008 cps to 10 MC. Each instrument is a precision, quality built equipment guaranteeing you highest stability, long term trouble free operation, and the convenience of compact size and wide frequency range. Brief specifications are given here; for complete details see your *-hp-* representative or write direct.

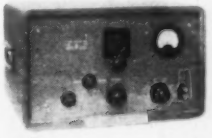
Instrument	Primary Uses	Frequency Range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 KC	1 watt/24.5 v	$120.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 KC	160 mw/20 v open circuit	150.00
-hp- 200 I	Interpolation, frequency measurements	6 cps to 6 KC	100 mw/10 v	225.00
-hp- 200T	Telemetry, carrier current tests	250 cps to 100 KC	160 mw or 10 v/600 ohms; 20 v open circuit	350.00
-hp- 201B	High quality audio tests	20 cps to 20 KC	3 w/42.5 v	250.00
-hp- 202A	Low frequency measurements	.008 to 1200 cps	20 mw/10 v	465.00△
-hp- 202B	Low frequency measurements	½ cps to 50 KC	100 mw/10 v	365.00△
-hp- 205AG	High power tests, gain measurements	20 cps to 20 KC	5 watts	440.00△
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 KC	+ 15 dbm	565.00△
-hp- 233A	Carrier test oscillator	50 cps to 500 KC	3 w/600 ohms	475.00
-hp- 650A	Wide range video tests	10 cps to 10 MC	15 mw/3 v	490.00△

3 of 11 famous -*hp*- oscillators

-*hp*- 200CD, 5 cps to 600 kc. Probably America's fastest selling precision audio oscillator. Offers highest stability, constant output, year after year dependability. 5 ranges, frequency response ±1 db, distortion less than 0.5%. Compact, weighs only 22 lbs. 300° logarithmic dial, 60" effective scale length. $150.00.



-*hp*- 202A Low Frequency Function Generator. Convenient, highly stable, multipurpose source of transient-free test voltages from 0.008 cps to 1,200 cps. 5 bands, distortion less than 1%, provides sine, square or triangular waveforms. 30 volts peak output, frequency response flat within 0.2 db. $465.00△.



-*hp*- 650A Test Oscillator. Provides fast, accurate tests from 10 cps to 10 MC. Extreme stability; output flat within 1 db full range. Voltage range 0.00003 volts to 3 volts. Output impedance 600 ohms. No zero set, no adjustment during operation. Output voltage attenuator, self-contained VTVM. $490.00△.

△Rack mounted instrument available for $15.00 less.

HEWLETT-PACKARD COMPANY

3336C Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK"

Field Representatives in all principal areas

Data subject to change without notice

PLEASE SEND INFORMATION ON MODEL _____ OSCILLATOR

Name _____

Company _____

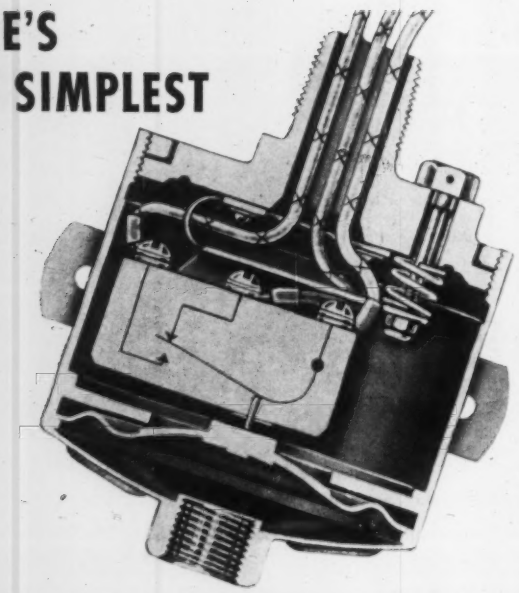
Street _____

City _____ Zone _____ State _____

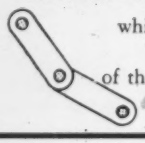
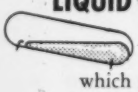
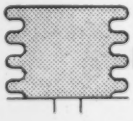
ELECTRONIC MEASURING INSTRUMENTS

For more information circle **25** on inquiry card.

HERE'S THE SIMPLEST



DIAPHRAGM PRESSURE SWITCH

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY This switch is guaranteed to repeat within + or — 1% of its original setting during its operating life.	**LINKAGES & BEARINGS**  which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS**  which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS**  which make the pressure switch sensitive to vibration.

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

Send operating data and specifications bulletins 420-27

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

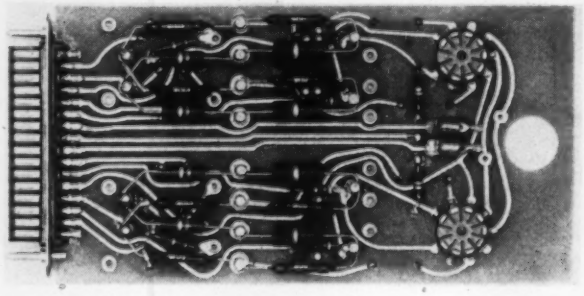
CITY _____ ZONE _____ STATE _____

For more information circle **26** on inquiry card.

the Regulus is thoroughly checked against improper wiring or accidental shorts before the missile is released to the Navy; up to 90 cables connect the panel to various points in the missile.

Graphic Circuits

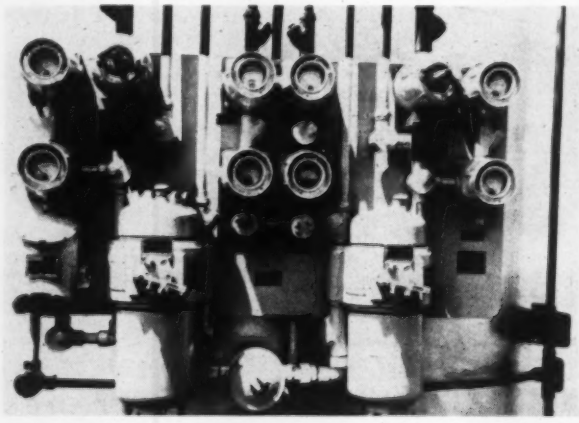
LOS ANGELES, CALIF.—Use of epoxy laminates in prefabricated etched circuits can minimize weight and space, save time and money, and eliminate human wiring



errors in electronic circuitry. A case in point is the use by Logistics Research, Inc., Redondo Beach, Calif., of etched circuits made from Epon epoxy-impregnated glass fiber in dual flip-flops used in the ALWAC digital computer.

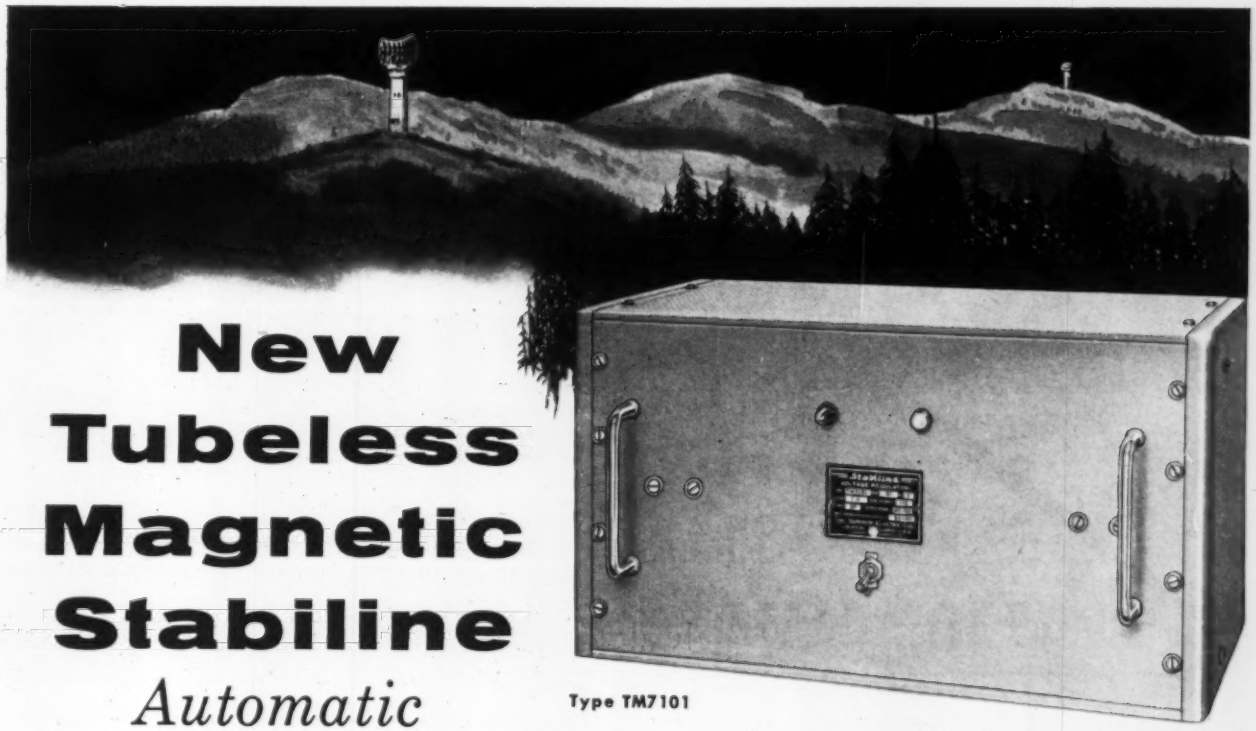
Explosion-Proof Panelboard

HOUSTON, TEXAS.—Explosion-proof Condulets protect the switches and instruments on this panelboard at a lubricating oil plant. The panelboard is the control center of an acid system electrical lube treater, manufactured by the Petreco Division of Petrolite Corporation, Houston, Tex-



as. Since the lube treater equipment is located in a hazardous area, cast-aluminum explosion-proof Condulets, manufactured by Crouse-Hinds Company, 7th North St., Syracuse, New York, are used to house the panelboard electrical units.

A Condulet permits explosive vapors to enter its interior through flame-tight joints. When vapors contact an arc, an explosion occurs. However, two factors keep the explosion and its effects within the Condulet. First, the Condulet housing is strong enough to withstand at least four times the pressure of such explosions. Secondly, explosion flames —contained by the walls of the Condulet—cannot escape. They are snuffed out and transformed into gases, which seep out the flame-tight joints cool and harmless into the atmosphere.



New Tubeless Magnetic Stabiline *Automatic* Voltage Regulators

Type TM7101

- *No tubes to replace*
- *No electromechanical parts to wear out*

STABILINE Automatic Voltage Regulators Type TM are the newest addition to Superior Electric's complete line of voltage control apparatus. Without tubes or moving parts it provides constant voltage regardless of line voltage or load changes. Where failure at any time under the most adverse operating conditions cannot be tolerated or where service is not a possibility over long periods of time STABILINE Type TM is a necessity. Both cabinet and rack models are offered. Send coupon below for full information.

FOR UNATTENDED LOCATIONS:
- Microwave relay stations
- Remote installations

FOR CRITICAL APPLICATIONS:
- Where sudden need for tube replacement can be costly (at a critical time in a process) or impossible (at an unattended location)
- Where conditions cannot tolerate moving parts

STABILINE Type TM7101 shown is rated:
1. Input — 95 to 135 volts
2. Output — nominal 115 volts can be adjusted from 110 to 120 volts
3. Output held within 1 volt band
4. Frequency range — 55 to 65 cycles
5. Waveform distortion — 3% maximum
6. Speed of response — less than 1.0 second for full range correction
7. Maximum load — 1.0 KVA.
8. Load power factor range — .5 lagging to unity

See Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY
BRISTOL, CONNECTICUT

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Buryl R. Hill Company, 19481 James Couzens Highway, Detroit 35, Michigan
Fred H. Haight Company, 3212 Eastlake, Seattle 2, Washington

THE SUPERIOR ELECTRIC COMPANY, 705 Reynolds Ave., Bristol, Conn.

Please send me full information on the new STABILINE Automatic Voltage Regulator Type TM (Tubeless Magnetic)

Name.....

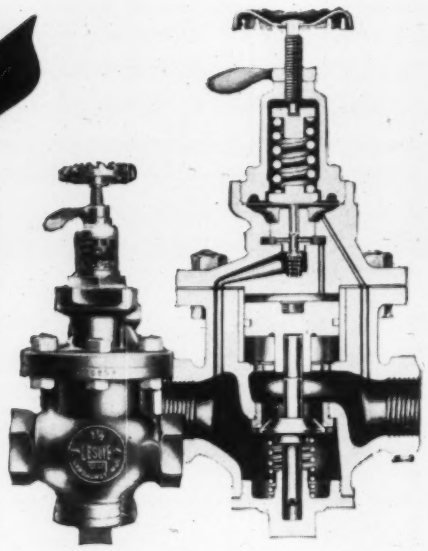
Company.....

Address.....

City.....Zone.....State.....

For more information circle **27** on inquiry card.

the PRESSURE'S ON!



STEADILY, CRITICALLY, AUTOMATICALLY, with

LESLIE

PRESSURE REDUCING VALVES

No need for costly, complicated two-stage reducing stations when you handle high pressure drops with Leslie Pressure Reducing Valves . . . *ideal* for steam heating installations or for process reductions.

Leslie design, materials and workmanship have proved successful for more than 55 years in all kinds of industrial heating applications. The single-seated, internal pilot, piston operated construction of Leslie regulators can handle pressure drops up to 1500 psi and higher and are being used successfully in pressure generating stations all over the U. S.

Send for the bulletin described below today.

- For Steam, Air, Gas
- 99% Accuracy of Regulation
- Instant Reaction to Flow Change
- Stellited Seating Surface
- Positive Dead-End Shut-Off
- Interchangeable Parts

BULLETIN 5302

Provides latest engineering data on all classes of Leslie Pressure Reducing Valves—assists you in planning and specifying for optimum performance. Yours on request.

TYPICAL PRESSURE RANGES

CLASS	BODY MATERIAL	SIZES	INLET STEAM PRESSURES	REDUCED PRESSURE RANGE
LLK	Cast Iron	½"-6"	25-250	2-35
LK	Cast Iron	½"-6"	25-250	10-235
LL-3	Cast Bronze	½"-4"	25-300	2-35
L-3	Cast Bronze	½"-4"	25-300	10-285
LL-4	Cast Bronze	5"-6"	40-300	5-35
L-4	Cast Bronze	5"-6"	40-300	20-275
IS-2	Cast Carbon Steel & Cast Alloy Steels	½"-3"	300-750	100-600
HS-3		1"-3"	300-1500	100-600

TRADE LESLIE MARK

LESLIE CO., 299 Grant Avenue, Lyndhurst New Jersey

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cppc OFFERS HIGH QUALITY SYNCHROS

Consistently!

By Customer's Testing—

REJECTION RATE .00095

ACTUAL SIZE

Out of 9000 synchros recently supplied a customer for a single job, the rejection rate by his testing of some 20 characteristics was .095% on each test. Nearly ¾ of the rejections were on minute differences of calibration measurements.

According to the customer, "this is far below rejection rates of 20% and 30% which we have experienced with regard to other sources of supply for like items."

A second customer reports that he has found CPPC synchros to have the next to the lowest rejection rate out of 500 suppliers. The only vendor having a lower rejection rate was a resistor manufacturer. (Names of both customers available on request.)

It costs no more to have the best! For highest consistent quality and accuracy, specify CPPC.

For full engineering information on size 10, 11, 15 and 22 synchros of virtually every type and available for 3 weeks or less delivery, write or phone, T. W. Shoop, Sales Mgr. Phone (Suburban Phila.) MAdison 6-2101.

West Coast Rep. Wm. J. Enright, 988 Kensington Rd., Los Angeles. MUtual 6573.

Direct Export Sales inquiries to: Andrew S. Szucs, Inc., 50 Broad St., New York 4, N. Y.

LOOK TO CPPC FOR cppc SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS COMPANY, INC.

CLIFTON HEIGHTS **PENNSYLVANIA**

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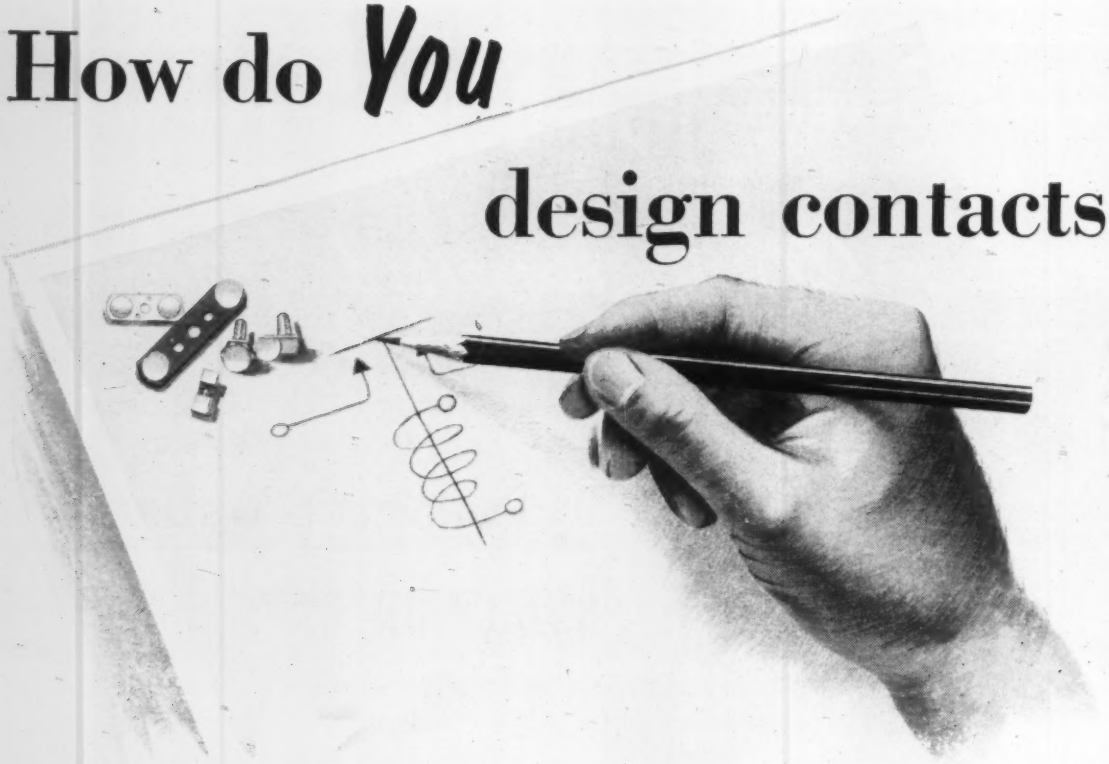
How do *You* design contacts?



CONTACTS can be *too good* for their job . . . in which case they add useless extra expense. Similarly, they can *fall short* of needed performance . . . and lead to costly repairs and loss of dependability. Unless you are engineering contacts exactly for your product's requirements, you may be missing opportunities to make substantial improvements in the performance and cost of your product.

To design contacts accurately for their intended use, *all* electrical, mechanical and environmental factors of the application require attention. How much current is to be broken, at what voltage, in what kind of circuit? How many make-and-break cycles . . . and how often? What contact pressures? What atmospheric conditions?

The answers to these questions . . . and many more . . . form the basis of Mallory's engineering of your particular contacts.

How Mallory Contact Engineering Helps You

Mallory engineers will help you select the most effective contact material from the extensive line of special Mallory alloys. If your application involves standard service conditions, a standard Mallory design can often be recommended . . . at substantial savings to you. For special requirements, Mallory engineers are well qualified to assist in design of special contacts . . . drawing on the experience gained in many years of contact research and development.

The result is a contact engineered exactly to your needs . . . capable of giving the performance you want, at a cost that fits the intended use. You can gain further savings, too, by having Mallory fabricate complete contact assemblies to your specifications in our efficient manufacturing plant.

Ask a Mallory engineer to talk over your own contact problems. For a consultation, or for a copy of our Contact Catalog, write or call Mallory today.

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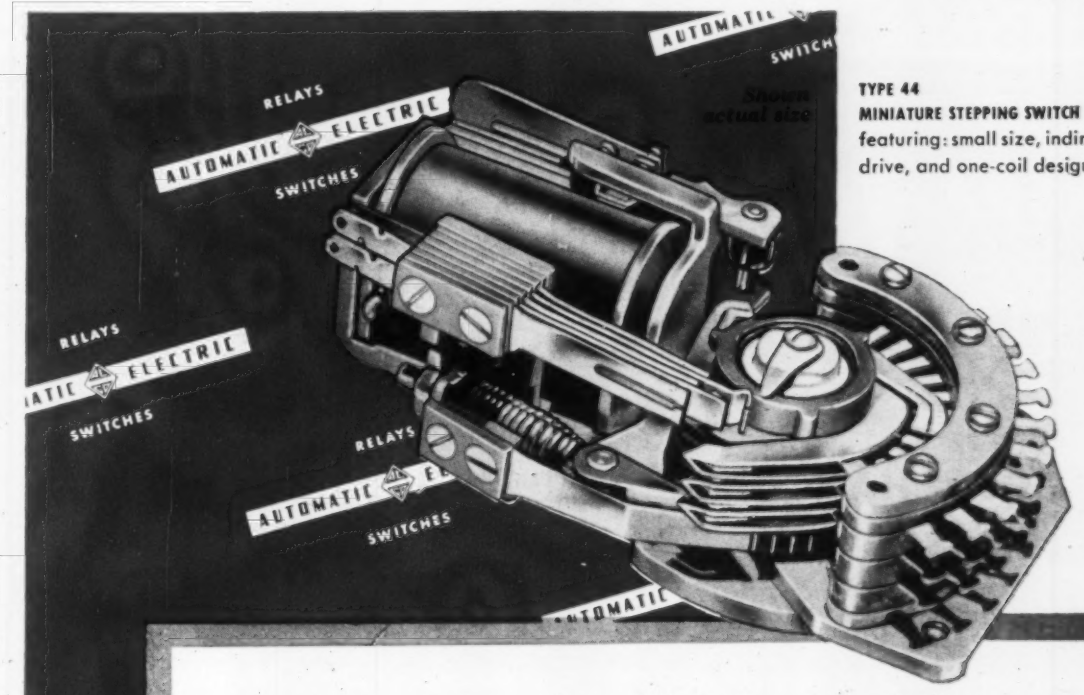

TYPE 44
MINIATURE STEPPING SWITCH
featuring: small size, indirect drive, and one-coil design.

Well-Adjusted

for a long, active life

200,000,000 operations, with little or no adjustment!

This rugged little stepping switch is racking up an outstanding service record in countless operations. It's Automatic Electric's Type 44 Miniature Stepping Switch, now going into more products than ever before!

Its cost-reducing features are impressive. One-coil design eliminates a separate release coil. Indirect drive gives smooth, high-speed stepping. There's no wiper "double loading" or galloping. Here's the first compact, lightweight switch for 10-, 20- or 30-point operations. Use any dc voltage up to 110 (with rectifier, up to 115 volts, 60 cycles, ac).

To improve your products without raising costs, get the full details on Type 44 and Automatic Electric's *complete* line of stepping switches. Write to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

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NOW...

THE 6000# HANCOCK STAINLESS STEEL

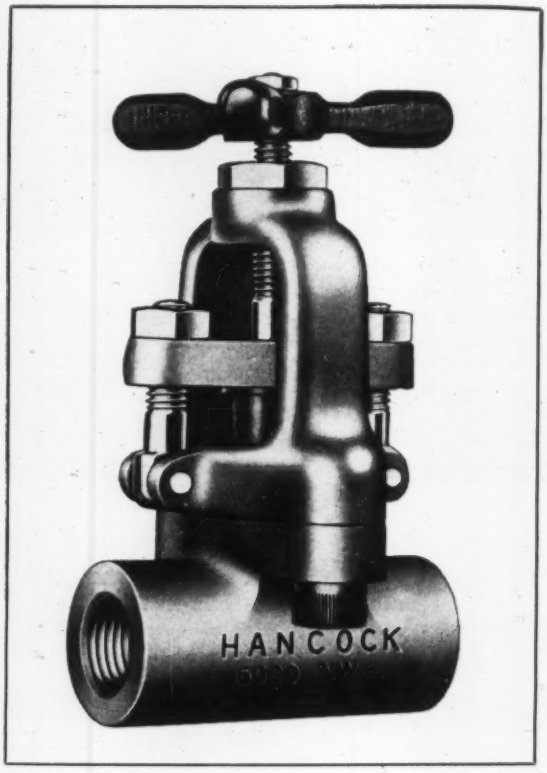
INSTRUMENT VALVE

A new HIGH PRESSURE valve for use on

INSTRUMENT PANELS
INSTRUMENT LINES
GAUGE LINES
BY-PASS LINES
CORROSIVE LINES
ORIFICE METERS

This heavy-duty Hancock Instrument Valve was specially engineered for these and similar services where high temperatures are of short duration and occur infrequently. It is small, easy to handle—weighs only 2¼ lbs. Space-saving compactness permits close alignment of piping with near structures. The packing gland can be readily pulled tight in close quarters. Disassembly is no problem in tight spots. Every practical use of stainless steel assures maximum protection against corrosion. You can be sure of long-life service and economical maintenance.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has the 6000# Hancock Instrument Valve. He is as close as your telephone. Call him for complete specification and operational data. You can count on fast delivery to meet your requirements.



SPECIFICATION DATA

SERVICE RATING: 6000# O.W.G.—100° F.
TYPES: Globe and angle.
SIZES: ¼", ⅜" and ½".
CONNECTIONS: Screwed and socket weld ends.
BODY: Type 410 forged stainless steel with integral stuffing box.
YOKE: Forged carbon steel—bolted to body with two hollow head alloy steel cap screws removable with Allen-type wrench. **No bonnet joint**—no gasket to leak or blow.
STEM: 300 Brinell stainless steel with bronze stem thread bushing.
STEM-DISC: Needle point design.
SEAT: Type 410 stainless steel. Integral with the body.
PACKING GLAND: Forged steel. Packing gland bolts, nuts, pins and packing stop rings—stainless steel.
PACKING: Highest quality long fiber asbestos, graphited and corrosion inhibited.
HANDLE: Malleable iron. Three-prong type for easy operation. Handle nut—steel.
MARKER PLATE: Stainless steel.

1877 HANCOCK U.S.A.

MAXWELL MANNING & MOORE INC. MM&M TRADE MARK

When Hancocks go in, valve costs go down

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

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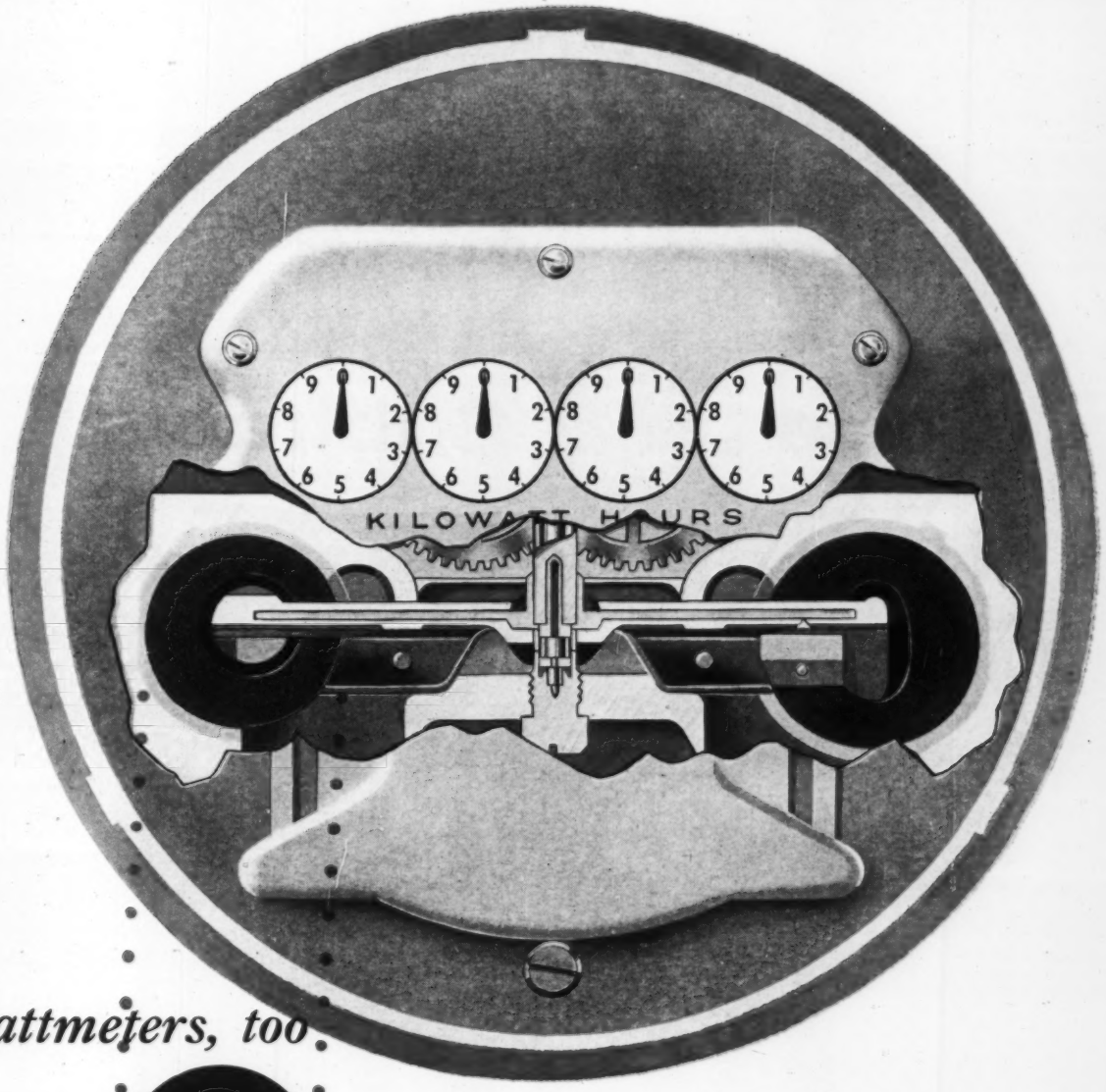

wattmeters, too.

USE CRUCIBLE PERMANENT MAGNETS

for maximum energy . . . minimum size

With Crucible alnico magnets you get *consistently higher* energy product . . . which means *more* energy from a *smaller* magnet.

That's why they provide maximum design freedom for manufacturers of watt-hour meters, voltmeters, and devices of all kinds requiring magnets from 0.2 ounces to several hundred pounds.

Crucible has been a leading producer of these powerful magnets ever since alnico alloys were first developed. And its magnet experience is backed by over a half-century of *special purpose* steelmaking.

For technical assistance in solving magnet applications, call Crucible. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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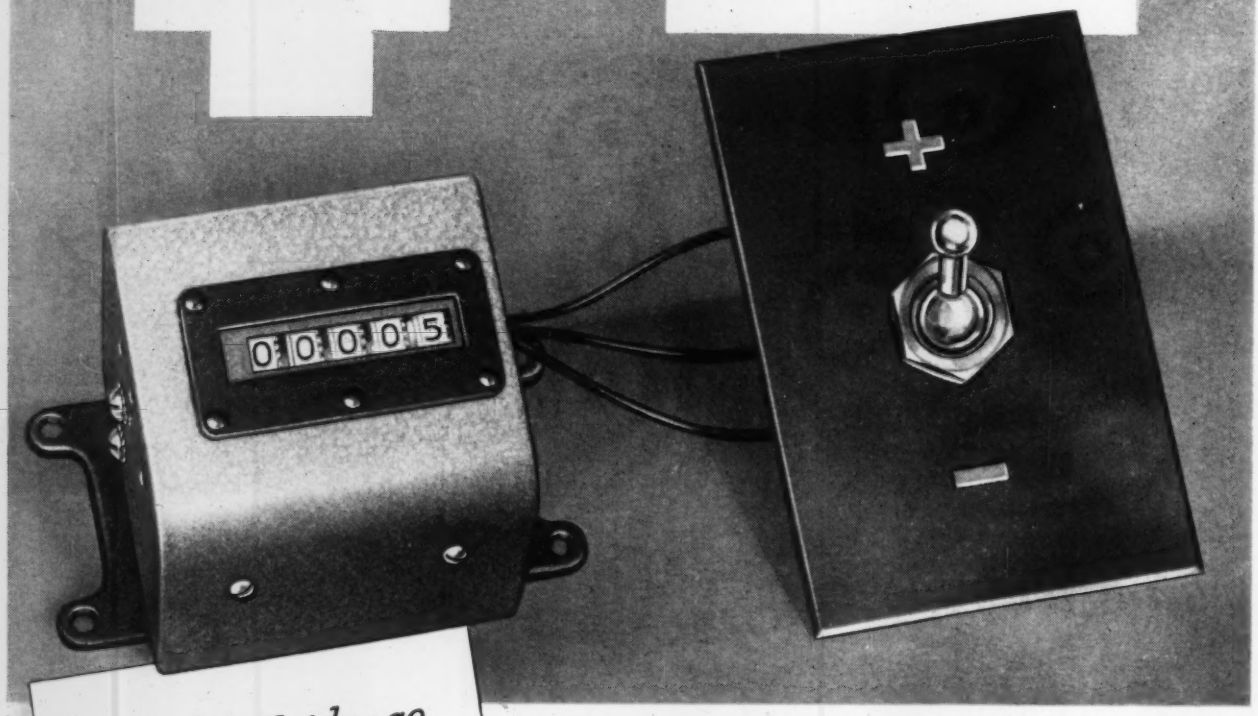
This Magnetic Counter

Adds and Subtracts



Added Evidence that —

Everyone Can Count on VEEDER-ROOT

Flip the switch up . . . the counter adds. Flip it down . . . it *subtracts*. And this 2-way countability makes this new counter a distinct asset to modern systems of automation, control engineering and stock control. Readily adaptable, easily installed and connected to existing circuits, the Veeder-Root "plus or minus" counter is a reliable double-check on the operation of machines, processes, systems. And it's just one of scores of standard and special Veeder-Root Counters for every field of reckoning from atomics to electronics to automation. What is *your* counting problem? Let's put a mathematical eye on it . . . write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

For more information circle **34** on inquiry card.

IS YOUR BELLOWS PROBLEM

a queer bird?

When you're up against an unusual problem in bellows, get in touch with Breeze. We design for tough applications where ordinary formed bellows cannot meet all the requirements. Custom-building of Breeze bellows permits more convolutions per inch for controlled flexibility; extra strength is *welded* into each diaphragm. Spring rate is precise.

Where necessary, Breeze can solve difficult vibration problems through special design, using plate-to-plate construction of proper metal and varying thickness.

Breeze *valve sealing bellows* provide a tight packless seal with required flexibility. Breeze *instrument bellows* meet pressure sensing needs from vacuum to 2000 psi. They are dimensionally stable and have low hysteresis. As *expansion joints* and *flexible connectors* they can withstand temperatures to 1400° F. All are job engineered.

We can also provide stainless steel *formed* bellows for operations where welded bellows are not required. Our engineers invite your inquiries.

BREEZE
CORPORATIONS, INC.
700 Liberty Avenue, Union, New Jersey

BREEZE MARK

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Want control for Water Heaters, Heat Exchangers, Processes?

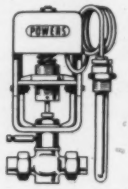
call POWERS

FLOWRITE
One of Powers Premium Quality Diaphragm Control Valves. They're simple, sturdy and dependable.

Over 60 Years of Temperature and Humidity Control

(c28)

You Will Insure Better Temperature Control IF—



you use the right type regulator and proper size control valve. Whether a simple self-operating regulator shown at left is required or the air operated controls featured here . . . you can get both types and others from Powers. For further information call or write our nearest office.

Powers ACCRITEM Temperature Regulator and FLOWRITE Valve—the right combination for many control problems where pressure and load conditions fluctuate widely, also for control of large size valves.

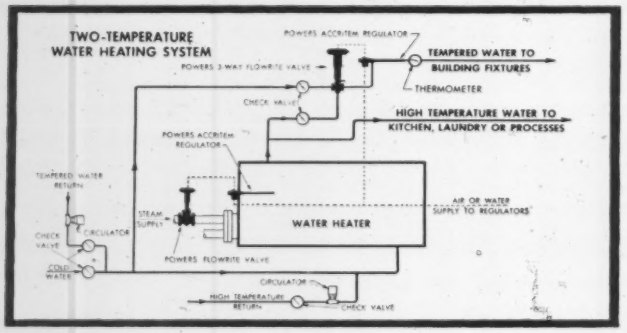
Over 50 Years Experience making this type of regulator

Control Point easily changed

Air or water operated

Ranges 50 to 250°F—150 to 350°F

VALVES: Available in a variety of body types and inner valves.

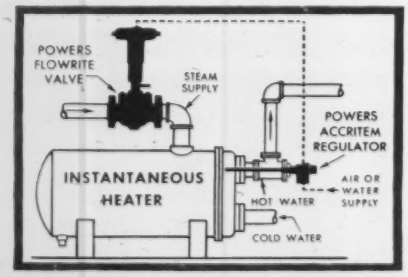


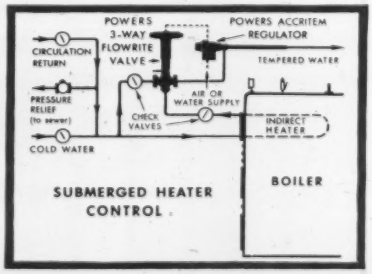
ACCRITEM TEMPERATURE REGULATOR

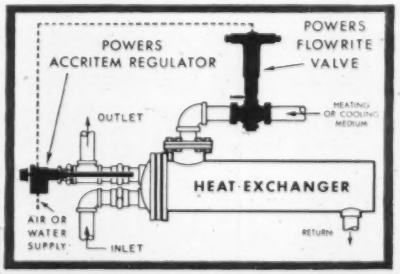
Gives Close Control and Years of Dependable Service.

- Has Adjustable Throttling Range and Calibrated Dial.
- Simple, Durable Construction assures years of trouble-free service.
- Easy to Install • Direct or Reverse Acting, reversible on the job.
- Small Size: Regulator head is 2⅞" wide, 3⅝" high, bulb is 12" long with ½" IPS Connection.

Fully Described in Bulletin 316. Write for a copy.







THE POWERS REGULATOR COMPANY | Skokie, Ill. • Offices in Chief Cities in U.S.A. Also Canada and Mexico • See your phone book

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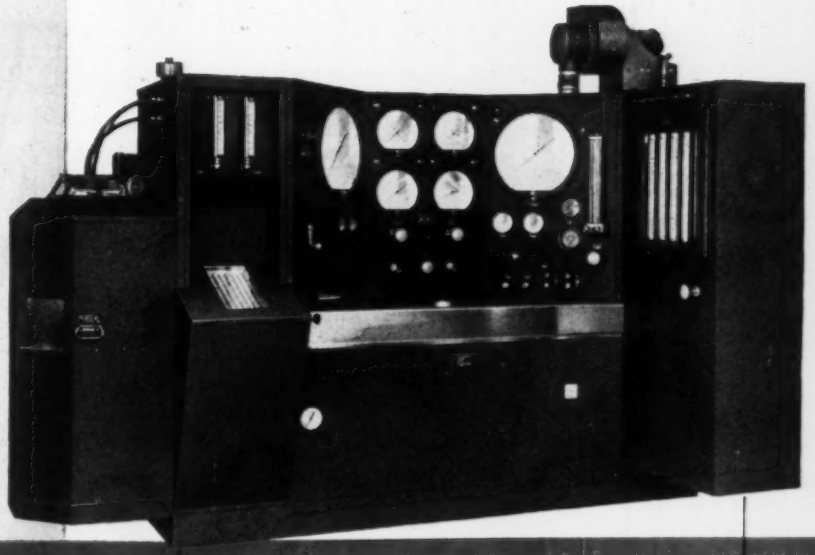
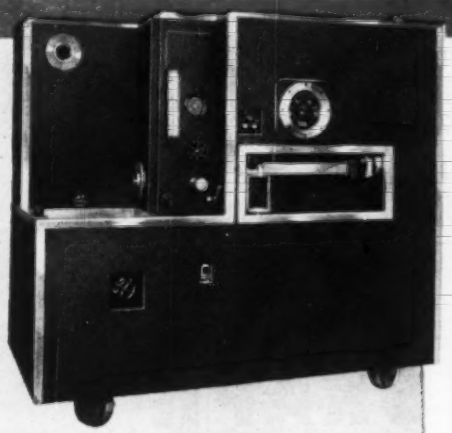
COX TEST STANDS

STAND THE TEST OF TIME!



TYPE 416 UNIVERSAL FUEL NOZZLE TEST STAND

Used by the aircraft industry to test for optimum efficiency of jet fuel nozzles, this highly accurate Cox Test Stand is a "complete modern hydraulics laboratory." Pressure, temperature, and flow rate can be controlled during testing to simulate the actual conditions under which jet fuel nozzles normally operate in the engine.



THE 309 FLOWMETER CALIBRATING STAND

More precision flowmeters are calibrated and checked on Cox Calibrating Stands of which the Type 309 is the latest, than on any other stand used by the automotive and aircraft industries. A precision-weighing mechanism weighs the flow through the flowmeter being tested, assuring precise calibration of the instrument. Portable Cox Calibrating Stands will accommodate single or multiple stage flowmeters of any make.

Other CRL *Products*

- **Single and Multiple Stage Flowmeters**
- **Engine Indicators**
- **Magnetic Thickness Gages**
- **Balanced Electronic Equipment for Measuring Pressure and Vibrations**
- **Vibration Study and Recording Equipment**

• When automotive and aircraft manufacturers first encountered the problem of determining in advance how certain engine accessories would perform under actual operating conditions, Commercial Research Laboratories engineers developed special test stands which would supply this information.

To test for optimum efficiency of jet fuel nozzles, for example, the nozzle is mounted in a Cox Nozzle Test Stand in which temperature and pressure are controlled and fuel is passed through the nozzle at the rate required. The fuel is automatically weighed by an electronic weighing device within the test stand and from this information the nozzle rate of flow is computed.

Cox precision-weighing Calibrating Stands are equally indispensable to automotive carburetor testing since the flowmeters which are used to measure the exact flow rate must themselves be calibrated and regularly checked on these portable, highly accurate stands.

Despite the difficult tasks these and other Cox test stands are called upon to perform in helping industry to solve complex testing problems, they have built up an outstanding record of many years of dependable service and performance.

Write us for descriptive literature and complete details on these and other Cox Test Stands — including Air Flowmeters and Carburetor Flow Stands.

Commercial Research Laboratories, Inc.

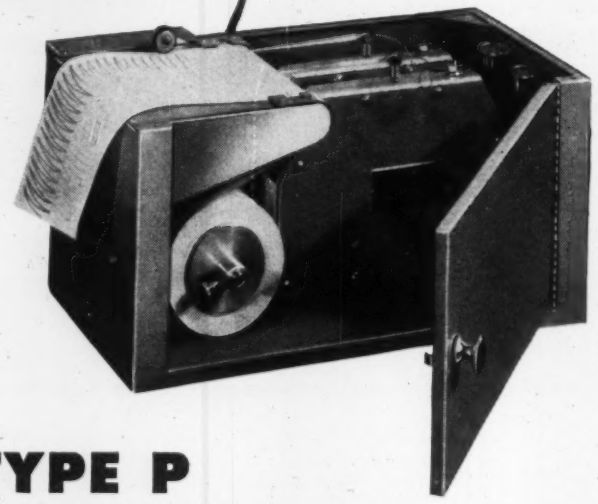
20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

Makers of COX *Since 1912*

REGISTERED TRADE MARK

For more information circle **37** on inquiry card.

NEW

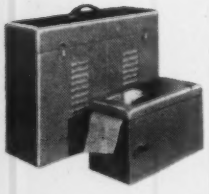


. . . 15 Microvolts D-C Sensitivity

. . . Absolutely Stable

. . . Complete Versatility

NEW...OFFNER TYPE P
PORTABLE DYNOGRAPH



This high speed, direct writing oscillograph recorder provides exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type gauges without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph are made possible by the exclusive, patented chopper amplifier. It is used for recording a wide variety of transient variables, such as strain, vibration, temperature, analog computer write-out, etc.

The performance specifications of the Type P Portable Dynograph are identical with those of the Type M Console model, but it is mounted in two convenient carrying cases as illustrated. The Type P is available with one or two channels.

Check these exclusive features:

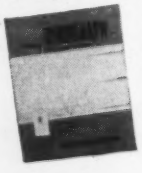
Speed plus sensitivity. The Dynograph gives you the maximum in speed and sensitivity—15 microvolts d-c per millimeter deflection with a response speed of less than 1/120th second.

Large easy to read records. Over 8 cm excursion, permitting the recording of large dynamic variations. Chart speeds 1 to 100 mm per second.

Absolute non-drifting stability. The Dynograph is absolutely stable and non-drifting—it is stable when it starts working and has *absolutely zero* base line drift.

No Hysteresis. The high-torque movement always returns the stylus to the base line—even with the paper stationary. Linearity is within one percent for four cm.

Compare and you will select the Dynograph



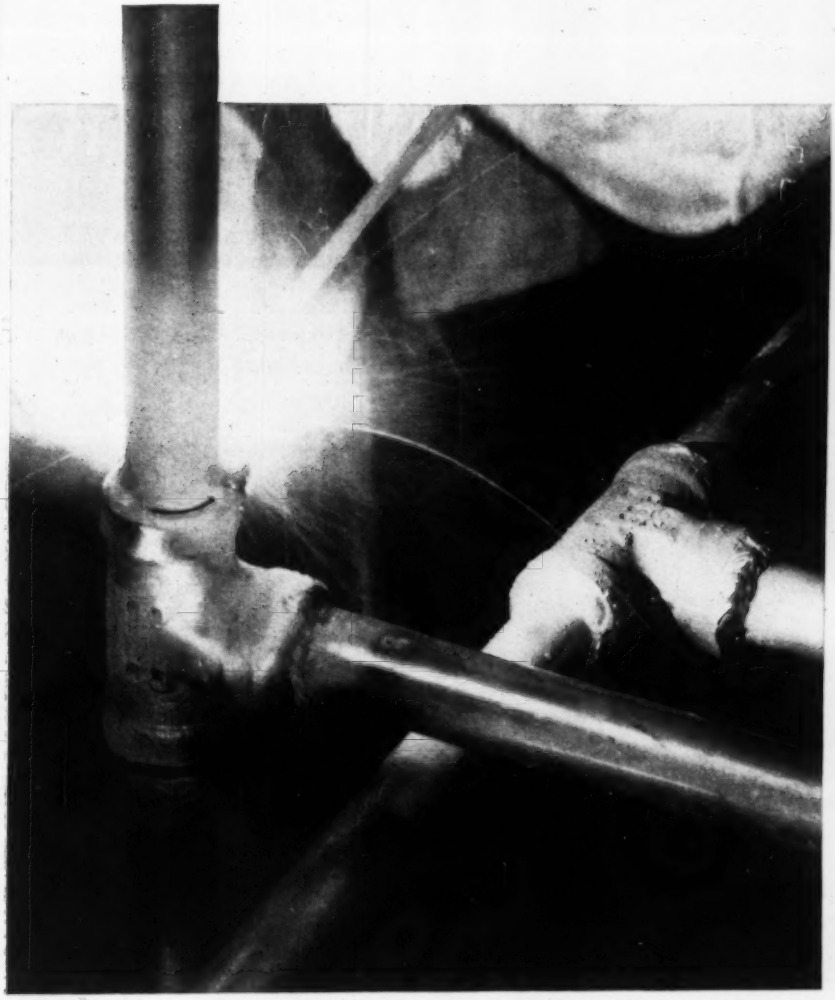
Write for your copy of Bulletin L-742. It gives you complete details and application information on both portable and console models of the Offner Dynograph.

OFFNER ELECTRONICS INC.

5326 North Kedzie Avenue • Chicago 25, U.S.A.

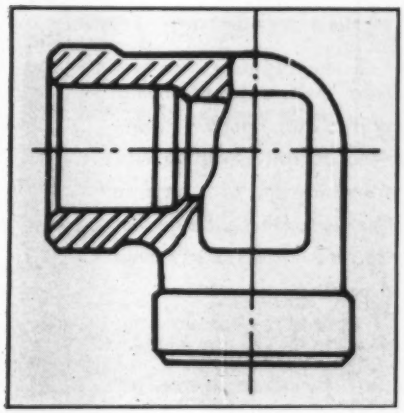
For more information circle **38** on inquiry card.

Announcing Parker Weld-lok tube fittings

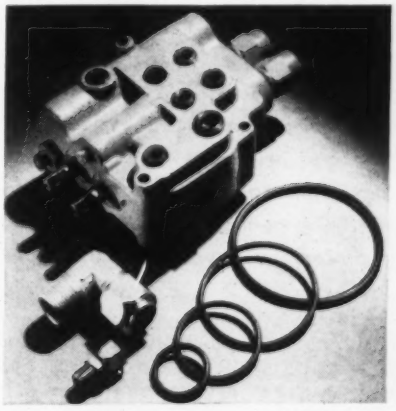


machined from high-quality steel or stainless steel bar stock and forgings . . . for tubing ¼ through 2 inches O. D.

Simply insert tube; then weld! No wonder Parker's new *Weld-lok* tube fittings are so easy to use . . . for applications involving extreme temperatures, corrosion conditions, or wherever permanently welded joints are needed. With *Weld-lok* fittings, you get permanently tight lines . . . unaffected by vibration, shock, or thermal distortion. They're offered for tubing sizes ¼ through 2 inches O.D.—steel or stainless steel.



Tapered socket of *Weld-lok* fittings aligns and holds tube, while you weld. You don't need special fixtures or equipment to make correctly proportioned weld.



What other Parker products interest you? *Triple-lok* flare tube fittings or *In-tru* flareless tube fittings for instrumentation? Hydraulic control valves? O-rings?

TUBE AND HOSE
FITTINGS DIVISION
Section 410-Q
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

Send New Parker *Weld-lok* Catalog No. 4370

Name _____ Title _____

Company _____

Address _____

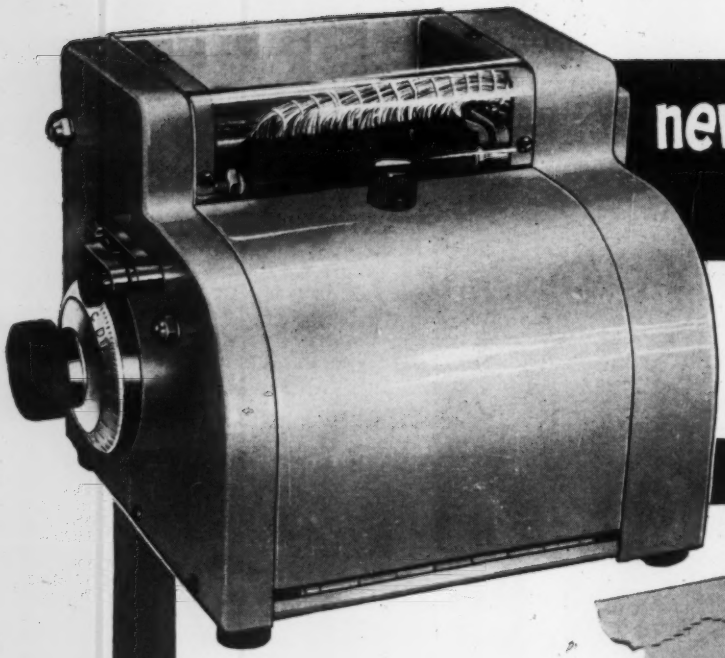
City _____ State _____

Mail this coupon for your copy of *Weld-lok* Catalog No. 4370. We will also send you the name of your nearest Parker distributor for *Weld-lok* tube fittings.

Parker

Hydraulic and fluid system components

For more information circle **39** on inquiry card.

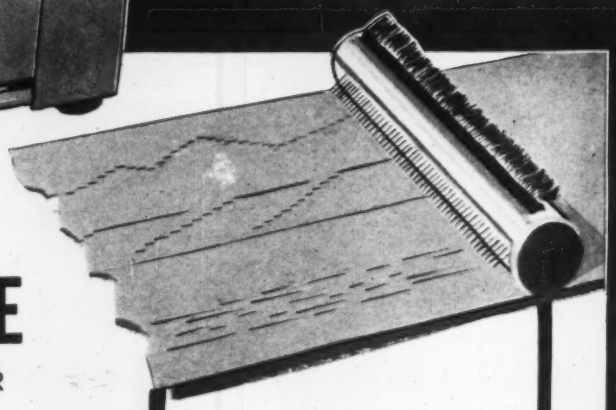


new MINI-SLEUTH

(MINIATURE RECORDER R1021-1)

A PORTABLE laboratory type recorder which allows immediate visual analysis of data.

WEIGHS ONLY 15 lbs.— Light, compact, portable — Dimensions: 9½"x7½"x 8"



212-styli recording head is unaffected by vibration and shock. 5-inch electro-sensitive paper chart provides direct writing on a dry, permanent record. Visible writing without ink or moving writing elements. Chart speed variable from ¼" to 5" per second.

INEXPENSIVE

MONITORING SYSTEM FOR

ON/OFF SEQUENTIAL RECORDINGS

The **MINI-SLEUTH** with its 212 writing styli is a new concept in instrumentation technique . . . a mighty mite of versatility, flexibility and ease of application.

The **MINI-SLEUTH** is a simple means of performing the heretofore complex problems of digital, analog and sequential data recording. It further offers expedient data reduction capability being performed during the recording process by visual or automatic techniques.

Radiation, Inc. fixed multi-style recording systems, featuring large data handling capabilities, help to economically simplify the solutions to instrumentation problems in Aircraft, Missile, Chemical, Mining, Petroleum and other industries. We invite you to submit your inquiries and application problems.

WRITE FOR FULL DETAILS

WRITE FOR CHARTS OF TYPICAL APPLICATIONS:

(1) Automatic Sequence Operation Monitor
(2) Production Sequence Time Monitor
(3) Automatic Cable Tester
(4) Digital Recording

RADIATION, Inc.

Dept. 101 • P.O. Box # 37 • Melbourne, Florida

For more information circle **40** on inquiry card.

TINY TITAN

Automatically controls hydraulic systems

up to 1000 p.s.i.

...up to 5.4 g.p.m.!

"HI-PRESSURE" HYDRAULIC V10 Series Only 3 7/16" high

The Skinner V10 *hydraulic* valve was especially designed for the age of automation. It is small, but as powerful as Hercules . . . built to give dependable, trouble-free service through

millions of cycles!

The V10 is a spring-loaded, direct-acting slide-type valve with internal parts made of stainless steel. Its precision-honed bore and centerless-ground, heat-treated plunger guarantee controlled leakage — at pressures up to 1000 p.s.i. and flow up to 5.4 g.p.m.! It is especially suitable for operating cylinders in machine tools, door openers, etc.

Like all Skinner solenoid-operated valves, the V10 is furnished with highest grade, varnish-impregnated "Nema Class A" coils. Molded, waterproof coils are available on request.

SPECIFICATIONS

Pressure Rating — 0-1000 p.s.i. [safe maximum (burst) pressure: 3000 p.s.i.]
Type — two- or three-way, normally open, normally closed, or directional control.
Effective orifice diameter — 3/32"
Pipe Size — 1/8" NPT (also available with ports drilled into bottom of valve body for direct mounting).
Electrical Outlet — Grommet-type or 1/2" NPT conduit (housings can be rotated 360°).
Voltages — all common AC and DC voltages.
Maximum Power Consumption — AC — 10 watts; DC — 12 watts.

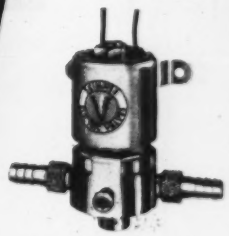
Do you have a solenoid valve problem? Call in a specially trained Skinner resident engineer— he'll tackle your problem immediately.

GENERAL SERVICE & VACUUM
V5 Series
2- & 3-Way
0-1000 p.s.i.

MINIATURE CUT-OFF
V2 Series
2-Way
0-250 p.s.i.

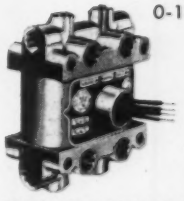
QUICK EXHAUST (extra fast cylinder return)
QV5-3 Series
3-Way
0-150 p.s.i.

HI-PRESSURE HYDRAULIC
V10 Series
2- & 3-Way
0-1000 p.s.i.

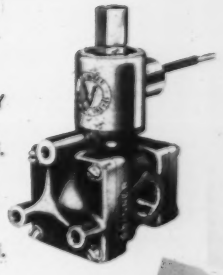


SANITARY
V4 Series
2-Way
0-20 p.s.i.

EXPLOSION-PROOF
X5 Series
2- & 3-Way
0-1000 p.s.i.



ALL-PURPOSE FOUR-WAY
V9 Series
4-Way 0-150 p.s.i.



HI-FLOW INDUSTRIAL
M Series
2- & 3-Way 5-150 p.s.i.

World-Wide Representation — Immediate Delivery on Standard Valves

SKINNER VALVES

SOLENOID

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIV.
The Skinner Chuck Company
116 Edgewood Avenue, New Britain, Conn.

☐ Please send me your new General Catalog.
☐ Please have a Skinner representative call on

Date.....
Name.....
Company.....
Street.....
City.....Zone....State.....

® THE CREST OF QUALITY

For more information circle 41 on inquiry card.

New

TRANSISTORIZED MINIATURIZED

SPECIFICATIONS

INPUT
20 to 35V DC
at approx. 5 m.a.

OUTPUT FREQUENCY
400 or 500 cycles

Type 2007T
+ −.02% from −65° to + 85°C.

Type R2007T
+ −.002% from + 15° to + 85°C.

Type W2007T
+ −.005% from −65° to + 85°C.

OUTPUT VOLTAGE
5 volts, sine wave.

Substantially uniform
from −65° to + 85°C.

LIFE EXPECTANCY
several times that of vacuum tubes

INTERNALLY SHOCK MOUNTED
on Silastic

MAGNETICALLY SHIELDED

HERMETICALLY SEALED

OCTAL BASE

SIZE
4½" x 1½" diameter

WEIGHT
7 ounces

COMPLETE INFORMATION ON REQUEST
PLEASE SPECIFY TYPE 2007T

Precision

FREQUENCY STANDARDS

These units, which are the result of several years of development and testing, offer a new standard of simplicity and reliability. Particularly noteworthy is the uniformity of output signal voltage with temperature change. Small size and light weight make them ideal for airborne and portable use.

For applications where only higher B voltages are available, a simple voltage reducing circuit may be used.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

For more information circle **42** on inquiry card.

Something New Under The Sun!

SEALED—RUGGEDIZED INSTRUMENTS BY ROLLER-SMITH HAVE THAT "NEW LOOK" FOR

Perfect Readability: **New shrouds designed by leading industrial designers focus attention to the large dial, assuring "one look" readability and enhanced appearance.**

Greater Accuracy: **New zero adjuster permits "split-second" adjustment from the front. No danger of leaks.**

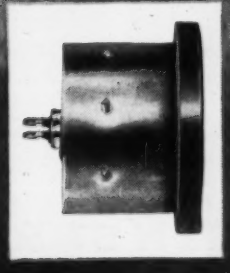
Simplified Maintenance: **New gasket seal perfected by Roller-Smith permits easy disassembly for service—NO expensive soldering equipment—NO wasted glass—you use the same glass over and over. Costs are reduced.**

Roller-Smith sealed and ruggedized instruments feature these three outstanding engineering and design improvements in all sizes from 1½ to 4½ inches to make them the most advanced on the market. Available in all practical ranges of AC and DC for accurate measurements under extreme environmental conditions.

Consult our engineering staff with over 50 years experience to solve your specific research and development problems.

Designed to comply fully with MIL-M-6A and MIL-M-10304 (Signal Corp.)

An extra feature—new "wrap around" shroud with gasket seal makes these meters as modern in appearance as they are in performance. Precisely built, their neat functional form expresses the forward thinking of our engineers.



ROLLER-SMITH

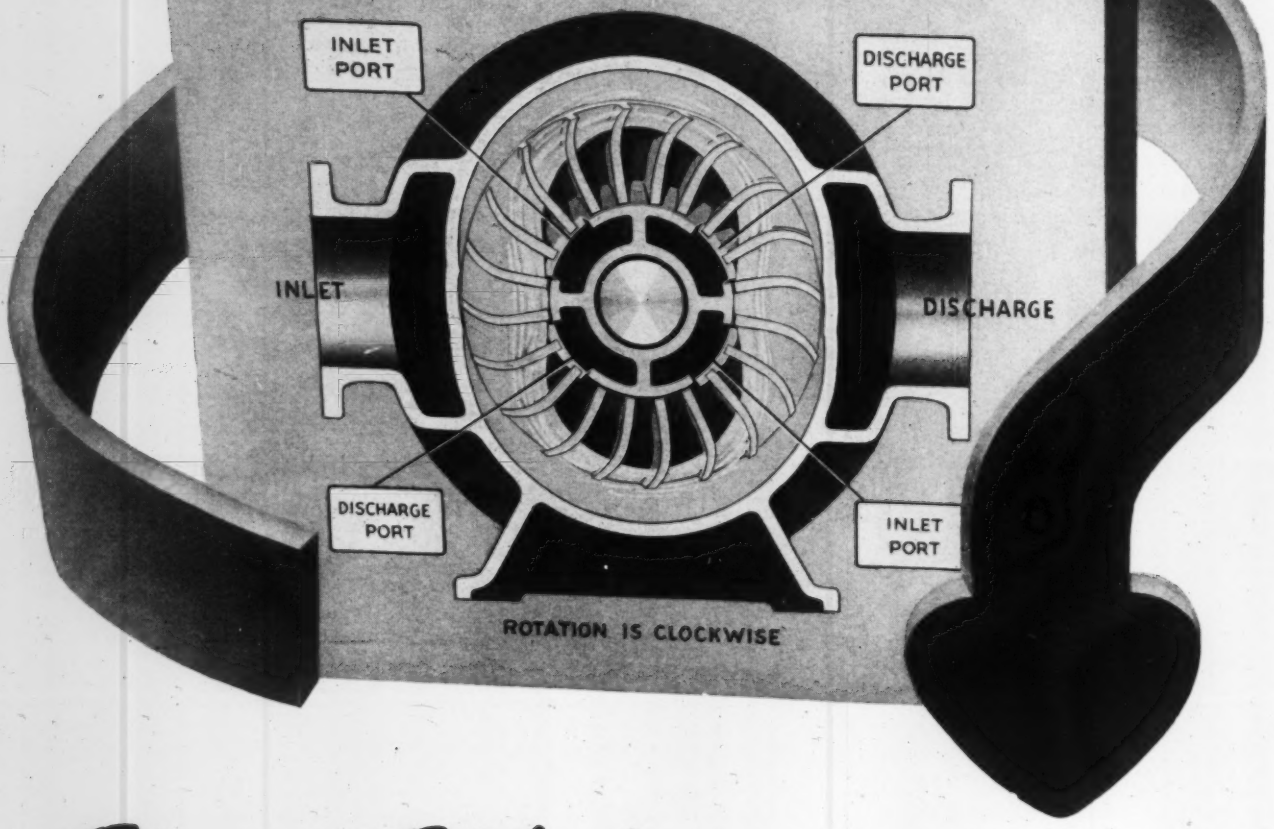
Instrument Division

FOR FORA

WEST MARKET STREET

Precision Products Since

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

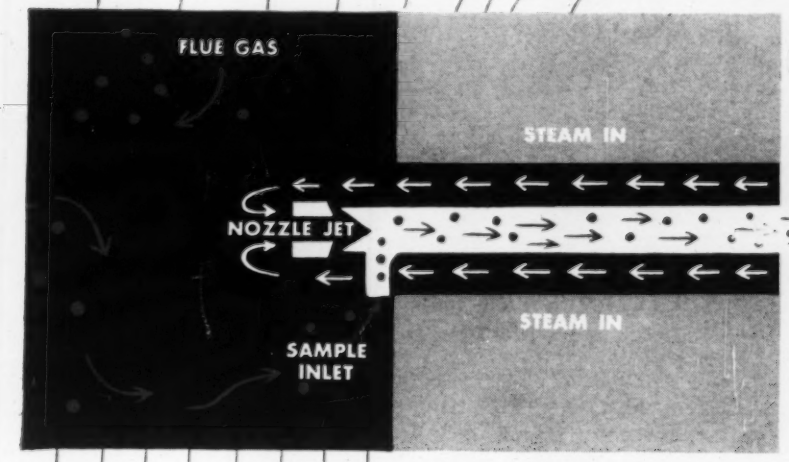
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

NEW DIMENSIONS



in Gas Sampling

NEW SAMPLING SYSTEM OPERATES ON STEAM!

The new Hays Gaspirator* System is designed especially for difficult gas sampling problems involving high dust loading and high temperatures. It now permits accurate O_2 measurement, previously impossible in many applications.

This gas sampling system uses steam to obtain a continuous, clean sample. Suction which is created by the jet nozzle draws the sample in, where it is mixed with the steam. The steam is then condensed. Condensate and entrained solids drop down, and the sample is forced through the analyzer under pressure.

Hays, in the field of gas analysis for more than fifty years, developed the Gaspirator for use with their Magno-Therm Analyzer.

This analyzer, which operates on the paramagnetic principle, has for years been accepted as the leader in the field of O_2 measurement. Hundreds of companies are using the Magno-Therm and Hays electronic recorders very successfully in boiler plants and on process furnaces as a combustion guide, in regeneration of catalysts in refineries and in many other process applications.

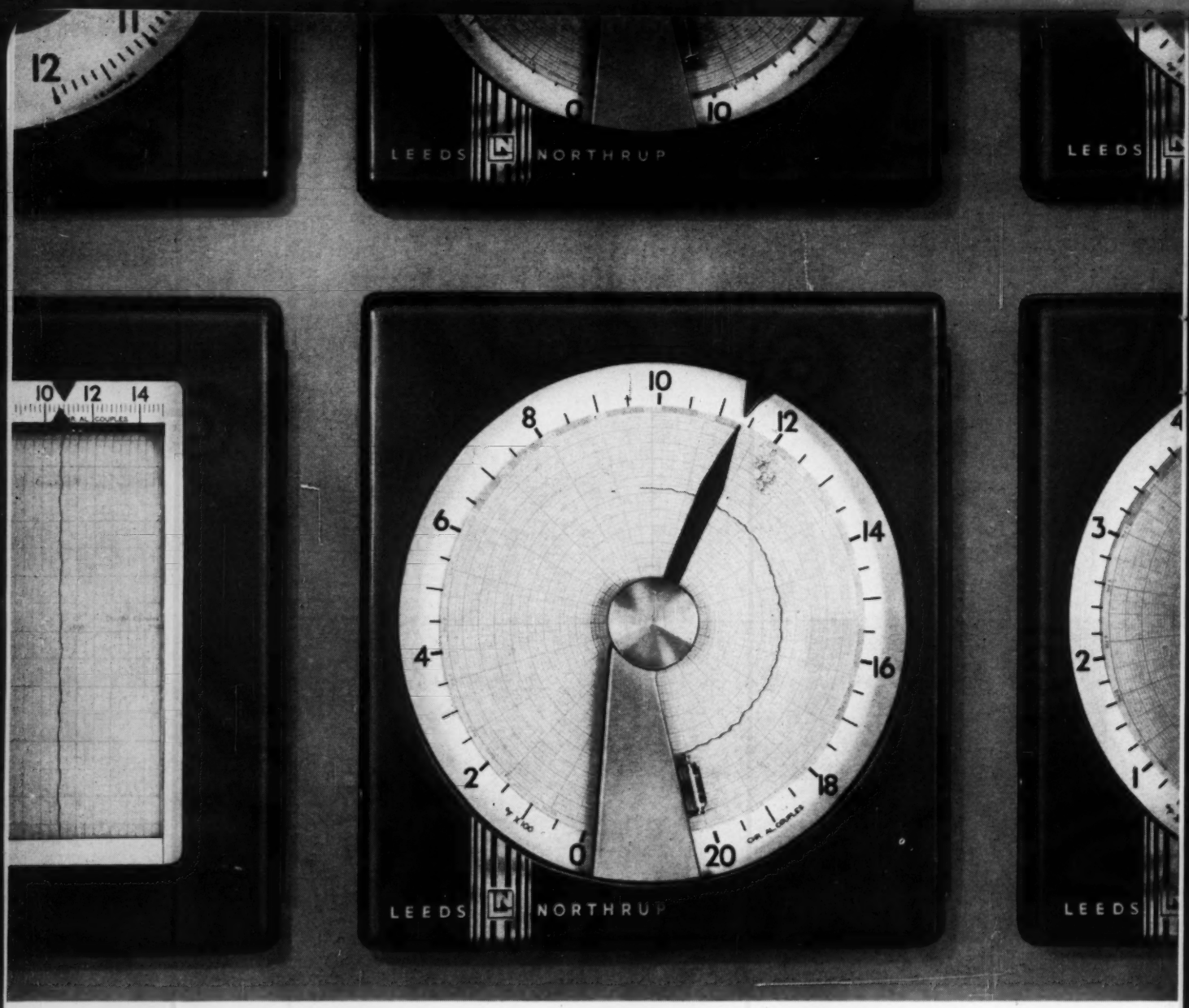
For further details write for Bulletin 55-829-56.

*Patents pending.

THE **hays** CORPORATION

MICHIGAN CITY 8, INDIANA

For more information circle **44** on inquiry card.



A new concept in panel space-saving . . .

less than 1 ft per unit

WITH SPEEDOMAX® H

● And that's the size of it . . . for a true null-balance potentiometer!

Only 11″ wide, Speedomax permits substantial savings in panel space . . . two of them can be mounted side-by-side in a 24 inch panel.

From the simplest indicator to the most complete standard controller . . . every Speedomax H combines this compactness with "big instrument" performance . . . outstanding simplicity of design with mechanical ruggedness.

Speedomax H is available for a broad range of temperature measurements, including many now being made with non-potentiometer instruments. It is being supplied as an indicator, recorder or controller . . . with a round or strip chart . . . for two position or the type of proportioning control you select, mounted as an integral space-saving unit.

To see the features of this unique instrument, get our pictorial fold-out which takes you inside Speedomax H. Just phone your nearest L&N office or write us at 4955 Stenton Ave., Phila. 44, Pa. Ask for Die-Out ND46(1).

For more information circle **45** on inquiry card.

LEEDS NORTHRUP
instruments *automatic controls • furnaces*

Editorial...

INSTRUMENTS and AUTOMATION

IRE National Convention

Annual highlight of the $8-billion radio-electronics field is the IRE National Convention. This year the Technical Sessions were held at the Waldorf-Astoria hotel, the Belmont-Plaza Hotel and at the Kingsbridge Armory; the show at the Kingsbridge Armory and the nearby Kingsbridge Palace, March 21-24.

The statistics emphasize the vast scope of this event—55 technical sessions; 275 papers; 704 exhibits; 40,000 attendance; $12 million of exhibits; 4 acres of exhibit area; miles of aisles. William Copp really produced an extravaganza for the IRE this year.

There was a lot of everything. You name it, the show had it. So your editor will give his impressions of the developments and trends.

The developmental emphasis seemed to be in the field of components, particularly solid-state devices such as magnetic amplifiers and transistors. Graphic circuitry is now the norm in equipments both small and large. Transistors are at long last finding standard use (the first transistorized radio—the Regency Radio using TI transistors is capturing the portable radio market). Interest is highest in fields of computers, instrumentation, and automation.

The following devices are of particular importance: In the field of computers, Wang Labs introduced the exciting new Digilog, a digital computer with simplified analog-type programming. The new Reeves analog computer introduced a unique self-checking feature. The Remington Rand high-speed printer was unveiled with speeds to 600 130-character lines per minute.

Of particular interest to instrument men: the DuMont transistor preamplifier with 1 microvolt referred-to-input noise and the DuMont strain gage and differential-transformer control systems. The new digitizer of Feedback Controls, Inc. The unitized digital counters of Brush Electronics. The D-1 d-c amplifier and MR-4 magnetic recording system of Southwestern Industrial Electronics. The new self-complementing decade counter and storage unit (tube) of IBM. The Airborne Instruments Lab. Cytoanalyzer for cancer detection. The new card translator (IBM-card to analog-voltages) of Moseley. The Servotherm infrared radiation pyrometer systems of Servo Corp. of America. The 30-watt transistor-magnetic amplifier and reactor-control instruments of Daystrom. The silicon grown-junction power diodes of Texas Instruments. The FM/FM telemetering systems of Bendix-Pacific. The new 900-cps. direct-writing oscillographic recorder of Technology Instrument Co. The DIVIAC shaft-rotation transducer of Feedback Controls. The magnetic tape recorders of A-V Mfg. The precision pressure balance (a pressure standard) of Consolidated Engineering. The Magnistor solid-state element of Potter Instrument. And apologies to the manufacturers of the 400 or 500 other devices for which there is no room for mention (but all of which will be reviewed in your New Instrument section of this magazine).

CIO Conference on Automation

The CIO Committee on Economic Policy held a National Conference on Automation at the Mayflower Hotel in Washington, D. C., April 14, 1955. Professor Don Campbell of MIT and John Diebold spoke for the automation industry. Senator O'Mahoney (D., Wyo.) and Walter Buckingham, Jr. (Associate Professor, Georgia Tech) spoke on "implications." Joseph A. Beirne (Communications Workers of America), James B. Carey (IUE-CIO), Walter Reuther (President, CIO and UAW-CIO) spoke for the CIO.

The issue was joined squarely on the economic factors—will or can automation cause unemployment? Our industry spokesmen gave out with the oft-repeated generalizations about how automation makes jobs. The union men then gave *facts* about the progressive growth of unemployment in 1954 in *expanding* automated industries. The generalities suffered in comparison with the facts.

The point that was, and is being, ignored by our industry spokesmen is that the economic health of the country is not determined by the degree of automation. Indeed, the converse is true. Hence Senator O'Mahoney's forthcoming investigation of automation (announced at this conference) represents the investigation of an effect, not of a cause.

This subject will be discussed in greater detail next month.

Correspondence on freezing point of water

In the March 1955 issue of I&A, the freezing point of air-free water was tabulated by the authors (A. B. Kaufman and P. R. Mitchell) as equal to 0.000 deg C, and that of air-saturated water as −0.0023 deg C.

Mr. L. F. Coleman of Argonne National Laboratory informed us that "the freezing point of air-saturated distilled water is 0.000 deg C because this is a 'fixed point' defined by the International Temperature Scale of 1948. The freezing point of air-free distilled water would then be +0.0023 deg C.

Mr. Kaufman replies:

"The Handbook of Chemistry and Physics states that 0 deg C is the temperature of melting ice—which we believe implies air-free water (in which event air-saturated water would freeze at −0.0023 C) . . . International Standards may now specify the freezing point of air-saturated water as 0 C, in which event air-free water would freeze at +0.0023 deg C."

Air always lowers the freezing or melting point. The issue here seems to be whether it is air-free or air-saturated water that freezes at 0.000 deg C. The 1948 International Standard refers to air-saturated water.

American Institute of Electrical Engineers
Conference on Magnetism and Magnetic Materials

JUNE 14-16, 1955 — **WILLIAM PENN HOTEL, PITTSBURGH, PA.**

TECHNICAL PROGRAM

TUESDAY, JUNE 14, 1955

8:00 A. M. Registration, William Penn Hotel, 17th Floor

9:00 A. M. Session No. 1. Urban Room

Opening Remarks and Welcome
R. M. Bozorth, Conference Chairman
Basic Magnetism
J. E. Goldman, Presiding

Magnetism and Electronic Structure
H. Brooks, Harvard University

The Process of Magnetization
C. P. Bean, G. E. Research Laboratories

Some Considerations on Double Exchange
P. W. Anderson, Bell Telephone Laboratories and H. Hasegawa, U. of Tokyo

The Role of Covalence in Oxides Containing Manganese
J. B. Goodenough, Lincoln Lab, M. I. T.

Collective Electron Model for Magnetization in Alloys
B. R. Coles, and J. E. Goldman, Carnegie Tech

Two Level Approach to Cooperative Phenomena
J. Rothstein, Signal Corps Engineering Labs., Fort Monmouth

Magnetic Properties of Beta—UH_3
S. T. Lin and A. R. Kaufmann, M.I.T.

Magnetic Properties of Pure Superconductors
N. Muench, T. S. Teasdale, J. Thompson, and C. F. Squire, Rice Institute

Ultrasonic Absorption in Superconducting and Normal Tin at Low Temperatures
H. E. Bommel, Bell Telephone Laboratories

2:00 P. M. Session No. 2 Urban Room

Magnetic Susceptibility and Resonance Phenomena
R. M. Bozorth, Presiding

Susceptibility Measurements on Paramagnetic Spinels and Metals at Very Low Temperatures
A. Arrott, and J. E. Goldman, Carnegie Tech

The Saturation Magnetic Moments in Iron-Aluminum Alloys M. T. Pigott, Penn State

Spin Wave Resonance In Ferromagnetic Metals
G. T. Rado and J. R. Weertman, N. R. L.

The Frequency Dependence of g-values in Polycrystalline Ferrites T. R. McGuire, N. O. L.

The Magnetic Susceptibility of Impurity Trapped Electrons and Holes in Semiconductors
E. Mooser, National Research Council, Ottawa, Canada

Powder Susceptibility of an Antiferromagnet
J. R. Tessman, Penn State

Magnetic Moment Arrangements and Magnetocrystalline Deformations in Antiferromagnetic Compounds
Y. Y. Li, Carnegie Tech

Strong Field Magnetization of $CrCl_3$ at Low Temperatures W. E. Henry, N.R.L., M. Griffel and W. N. Hansen, Iowa State College, Ames

Domain Walls in Antiferromagnetics and the Weak Ferromagnetism of Alpha Fe_2O_3 Y. Y. Li, Carnegie Tech

Magnetic Susceptibilities of Complexes of the Transition Elements M. Wolfsberg and N. Elliott, Brookhaven National Lab.

Low Temperature Heat Capacities of Some Normal Spinels
S. A. Friedberg and D. L. Burk, Carnegie Tech.

Diamagnetism of Free Electrons in Aromatic Lattices
H. T. Pinnick, U. of Buffalo

Static and Dynamic Magnetization Characteristics of Magnetic Amplifier Core Materials
E. Both, Signal Corps, Engineering Labs., Fort Monmouth

WEDNESDAY, JUNE 15, 1955

9:00 A. M. Session No. 3 Urban Room

Metallurgy and Structure
C. M. Zener, Presiding

Metallurgy of Magnetic Materials
J. F. Libsch and G. P. Conrad, Lehigh University

A Contribution of the Study of Ferrous Ternary Diagrams to Magnetic Interactions
U. H. Roesler, Westinghouse Research Lab.

Domain Configurations and Crystallographic Orientation in Grain-Oriented Iron-Silicon Alloy
T. G. Nilan and W. S. Paxton, U. S. Steel Research Laboratories

Effects of Stresses on Losses and Domain Configurations of Grain-Oriented 3% Silicon-Iron
P. W. Neurath, G. E. (Pittsfield)

Low Temperature Precipitation in Commercial 3% Silicon Steels F. S. Gardner, G. E. (Pittsfield)

Magnetostriction of Iron-Silicon Alloys in High Fields
B. A. Calhoun and W. J. Carr, Jr., Westinghouse Research Labs.

Deformation and Recrystallization of 3% Silicon-Iron
G. Wiener and R. Corcoran, Westinghouse Research Labs.

Some Notes on Ferromagnetic Properties of Alloys with Superlattice H. Sato, Westinghouse Research Labs.

Dislocation Movements in a Stress-Relief Anneal and Their Relation to Magnetic Recovery
C. G. Dunn, G. E. (Pittsfield)

Powder Metallurgy for Research into Ferromagnetic Materials C. E. Richards, E. V. Walker and A. C. Lynch, Post Office Eng. Dept. (London)

Magnetic Materials and Powder Metallurgy
H. Evans, C. G. Smith, and D. K. Worn, Mond Nickel Co. Ltd.

2:00 P. M. Session No. 4 Urban Room

Permanent Magnets and Fine Particles
J. A. Osborn, J. F. Libsch } Presiding

Recent Advances in the Field of Permanent Magnets
K. J. Sixtus, Indiana Steel Products Co.

The Electron Microscopy of Submicron Iron Particles
J. H. L. Watson, Henry Ford Hospital and M. W. Freeman, M. W. Freeman Co.

Effect of Shape Anisotropy on the Coercive Force of Elongated Single Magnetic Domain Iron Particles
T. O. Paine, L. I. Mendelsohn, and F. E. Luborsky, G. E. (Lynn)

An Approach to Elongated Fine Particle Magnets
I. S. Jacobs and C. P. Bean, G. E. Research Labs.

Permanent Magnet Properties of Elongated Single Domain Iron Particles
L. I. Mendelshon, F. E. Luborsky, and T. O. Paine, G. E. (Lynn)

Prefered Orientation and Magnetic Properties of Rolled and Annealed Permanent Magnet Alloys
W. R. Hibbard, Jr., G. E. Research Labs.

BiMn "Spire" Growth Induced by a Magnetic Field
B. W. Roberts, G. E. Research Labs.

Observation of the Magnetic Domains and Domain Wall in BiMn by the Kerr Magneto-optic Effect
B. W. Roberts, G. E. Research Labs.

The Anamalous Behaviour of Alnico V in the Sub-Curie Temperature of 1000-1450 deg. F.
J. R. Hansen, Crucible Steel Co.

New Facts Concerning the Permanent Magnet Alloy,

Alnico V.
E. A. Nesbitt and H. J. Williams, Bell Telephone Labs.

2:45 P. M. Session No. 4A — Fort Duquesne Room
Magnetic Amplifiers and Switching
A. C. Beiler, Presiding

The Noise Problem in the Coincident-Current Memory Matrix — J. D. Childress, Lincoln Lab., M. I. T.

The Influence of Pulsed Magnetic Fields on the Reversal of Magnetization in Square Loop Metallic Tapes
D. S. Rodbell and C. P. Bean, G. E. Research Labs.

Relation of DC Magnetic Properties of Oriented 48% Nickel-Iron to Magnetic Amplifier Performance (AIEE Transactions Paper #55-455)
M. F. Littman and C. E. Ward, Armco Steel Co.

Soft Magnetic Materials with Rectangular Hysteresis Loops
N. I. Ananthanarayanan, Westinghouse (E. Pgh.)

Magnetostriction in Ferrites Possessing a Square Hysteresis Loop
P. K. Baltzer, Lincoln, M. I. T.

Rotational Damping in a Thin Ferromagnetic Disk
T. L. Gilbert and J. Kelly, Armour Research Foundation

Dynamax, A New Crystal and Domain Oriented Core Material — G. H. Howe, G. E. Research Labs.

Topics in the Microwave Applications of Ferrites
J. Cacheris, G. Jones, and R. Van Wolfe, Diamond Ordnance Fuze Labs.

THURSDAY, JUNE 16, 1955

9:00 A. M. Session No. 5 — Urban Room
Ferrites — W. F. Meiklejohn, Presiding

Ferromagnetics and Ferroelectrics
A. von Hippel, M. I. T.

Applications of Ferrites
V. C. Wilson, G. E. Research Labs.

Recent Developments in Microwave Ferrite Devices
S. Weisbaum, Bell Telephone Labs.

Ionic Distribution in Ferrites
H. B. Callen, U. of Pa., S. W. Harrison and C. J. Kriessman, Remington Rand

Initial Permeability as a Function of Temperature for Certain Ni-Zn Ferrites
J. M. Blank and N. Schwartz, G. E. (Syracuse)

Magnetic Anisotropy of Cobalt Ferrite and Nickel Ferrite
H. Shenker, N. O. L. and U. of Maryland

Initial Permeability in Ferrimagnetic Spinels
R. S. Weisz, R. C. A.

The Effect of Minor Additions of Manganese or Cobalt in High Resistivity Nickel-Ferrites
L. G. Van Uitert, Bell Telephone Labs.

2:00 P. M. Session No. 6 — Urban Room
Apparatus and Magnetic Design
M. P. Getting, Jr., Presiding

Interrelation of Manufacture, Magnetic Properties and Engineering Design of Magnetic Apparatus
T. J. Murrin, Westinghouse (Sharon)

Magnetic Effects of Compressional Stress at Low Field Intensities — R. E. Fischell, N. O. L.

The Effect of Fringing of Air Gaps in Hipersil Cores
A. S. Poulsen, Westinghouse (Baltimore)

A New-Low Field Magnetometer for Measuring H of Small Soft Magnetic Specimens
R. D. Robinson and P. G. Frischmann, G. E. Research Labs.

Effect of Temperature on the Permeability and Core Loss of Electrical Steels — J. J. Clark, Westinghouse (E. Pgh.)

Stability Characteristics of Molybdenum Permalloy Powder Cores — C. D. Owens, Bell Telephone Labs.

An Accurate Electronic Tracer for Dynamic Characteristics of Magnetic Materials (AIEE Transaction Paper #55-454)
E. Kittl, Signal Corps Eng. Labs., Fort Monmouth

The Synthalizer System; An Automatic AC B-H Loop Recorder
E. R. Czerlinsky and R. MacMillan, Air Force Cambridge Research Center

A Vibrating Coil Magnetometer and Its Application to the Study of the Curie Point of Magnetite
D. O. Smith, M. I. T.

Radio-Frequency B-H Tracer and Power Measurements of Ferrites — B. Christensen, Westinghouse (E. Pgh.)

EXHIBITORS and their PRODUCTS

Arnold Engineering Company, Marengo, Illinois
Magnetic materials: permanent magnets, high permeability cores

Bell Telephone Laboratories, Inc.
Murray Hill, N. J.
Magnetic materials in communications equipment

Carboloy Dept. of General Electric Co.
Detroit, Michigan
Permanent magnets, thermistors, thyrites

The Carpenter Steel Company, Reading, Pa.
High nickel alloy parts for: temperature compensator alloys, low expansion alloys, glass sealing alloys

Crucible Steel Company of America
Pittsburgh, Pennsylvania
Magnets, magnet assemblies, precision instrument castings

General Electric Co., Schenectady, N. Y.
Gaussmeter, fluxmeter, recording hysterisigraph

Hamner Electronics Co., Inc., Princeton, N. J.
Dynamic voltage tracer, an instrument that provides X-Y plot of dynamic characteristics. Vari-flex chassis and power supplies—a relay rack panel and chassis kit

The Indiana Steel Products Company
Valparaiso, Indiana
Permanent magnets; non-metallic ceramic permanent magnets; speaker magnets

Instruments Publishing Company
Pittsburgh 12, Pennsylvania
"Instruments and Automation" magazine; "Instrument and Apparatus News", "Instrument Manufacturing", technical books

Magnetic Instrument Co., West Orange, N. J.
Magnetic amplifiers, voltage regulators

Magnetic Metals Company, Camden 1, N. J.
Electromagnetic core parts and shields

Magnetics, Inc., Butler, Pennsylvania
Tape wound cores; ultra-thin cores; shields; laminations; powered permalloy cores

Minnesota Electronics Corp., Subsidiary of Librascope, Inc., Burbank, Calif.
Magnetic components and decision elements

Raytheon Mfg. Co., Waltham, Mass.
Magnetizer

Rese Engineering, Inc., Philadelphia 6, Penna.
Magnetic core pulse analyzer for analyzing square-loop magnetic cores; automatic handler for high speed testing of cores

Rubicon Company, Philadelphia 32, Pennsylvania
Fahy simplex permeameter; reflecting galvanometer; D. C. spotlight galvanometer; high pressure potentiometer; portable precision potentiometer

Thomas & Skinner Steel Products Co., Inc.
Indianapolis 7, Indiana
Permanent magnets, orthosil tape wound "C" and toroidial cores, electrical laminations

Westinghouse Electric Corp.
Pittsburgh, Pennsylvania
Magnetic amplifiers and alloys

New Instruments...

INSTRUMENTS and AUTOMATION

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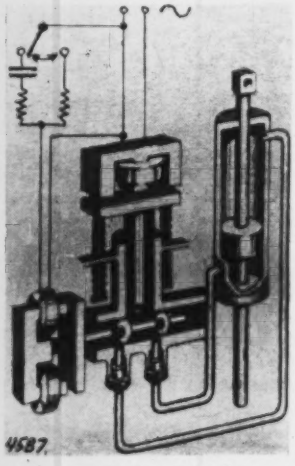
POSITION, ANGLE, ETC.

Electro-hydraulic Positioner

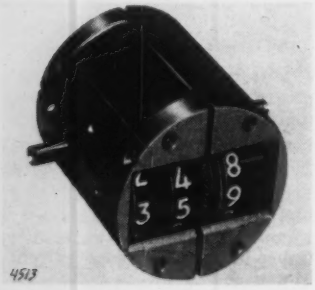
New "Hydromagnet" is an electric-hydraulic positioner. Operation is as follows: Hydraulic pump is actuated by a "pumping" vibrator (top). Flow from vibrator is controlled by a "steering" vibrator (side), into one or the other side of a power piston (right). Direction of flow of hydraulic fluid is determined by phase relationship between the "pumping" vibrator and the "steering" vibrator, and is changed by switching a capacitor into and out of the connecting electrical circuit. Performance varies between full output stroke of four inches in two seconds (for a 44-lb load) and full output stroke of four inches in 8 seconds (with 172 lb load). —*Donald C. Seibert, Box* 281, *Wilmington, Dela.*



For more information circle **201** on inquiry card.

Shaft-angle Digitizer

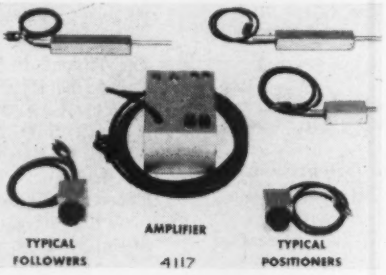
New "Model 1502 Angle Counter" indicates angular changes of shaft from 0 to 359 degrees and back to 0, in 1-degree divisions; is equally useful in clockwise, counterclockwise or reversible applications. Maximum speed 500 rpm.—*Bowmar Instrument Corp.*, 2415 *Pennsylvania St., Fort Wayne, Ind.*



For more information circle **202** on inquiry card.

Remote Positioner

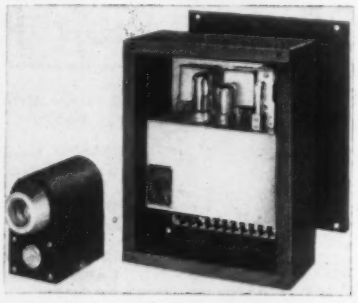
New remote positioner suitable for linear or rotary motion permits full travel, oscillatory action or any pattern of movement desired; can be actuated manually, pneumatically, hydraulically or mechanically; provides a closed-contact circuit to accomplish proper directional movement of device being controlled until positioner and follower are in balance.—*Bar Products Co.*, 17702 *Waterloo Rd., Cleveland* 19, *Ohio.*



For more information circle **203** on inquiry card.

Registration Controller

"Type 23LF3 Model 1006" operates continuously over high and low speed ranges without special attachments; responds instantly to appearance of a mark printed on material moving past at 500 fpm.—*Photoswitch Div., Electronics Corp. of America,* 77 *Broadway, Cambridge* 42, *Mass.*



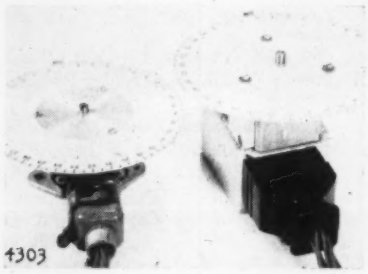
For more information circle **204** on inquiry card.

CONTENTS OF THIS DEPARTMENT

Position, Angle, &c.	726	Electrical Testing	747
Recording	727	Electr. Instruments	750
Temperature	728	Electr.-instrument Accessories	757
Force, Load, &c.	730	Amplifiers	759
Pressure	731	Elec. Components	761
Flow	733	Electromechanical Components	763
Time, Speed, Count	734	Motors, &c.	767
Computing	736	Mech. Comp's	769
Nucleonics	739	Valves	770
Laboratory	740	Miscellaneous	774
Shop & Automation	742	Power Supplies	776
Mechanical Testing and Inspection	746		

Remote Positioner

New "Torsynator," said to be capable of replacing servomechanism systems in many applications, comprises a voltage dividing resistor as sender and a low-inertia d-c. motor as receiver. Accuracy within 0.4 deg.; starting time 0.02 sec.; output power better than 0.1 watt; total weight including receptacles, 19 oz. Other "Torsynators" include 60- and 400-cps. types and 60-watt power unit, follow-up speed of 720 deg./sec.—*Air-Marine Motors, Inc.*, 369 *Bayview Avenue, Amityville, L. I., N. Y.*



For more information circle **205** on inquiry card.

Rotation Pickup

New "Rotary Variable Differential Transformer" provides a voltage proportional to shaft's angular position. Primary excitation 3 to 6 v., single-phase, 0.4 to 8 kc. Normal sensitivity 0.004 v./deg. at 2000 cps. (with 5-v. input). Accuracy 1 to 3 percent depending on temperature.—*Schaevitz Engineering, Camden* 1, *N. J.*

For more information circle **206** on inquiry card.

Turns-counting Dial

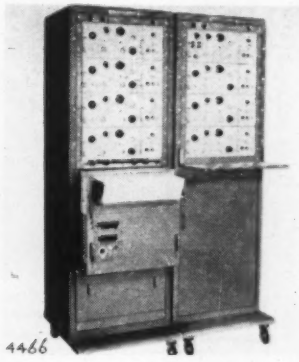
New "SR Series Duodial," 1-5/32-in. diam., for use with maker's "AJ Series Helipot," is equally useful with any rotating component having a ⅛-in. diam. shaft; comprises two coaxial dials: inner dial counts hundredths of each turn; outer counts completed turns up to 10.—*Helipot Corp.*, 916 *Meridian Ave., South Pasadena, Calif.*

For more information circle **207** on inquiry card.

RECORDING

Recording Systems

New six- and eight-channel models have been added to maker's "150"

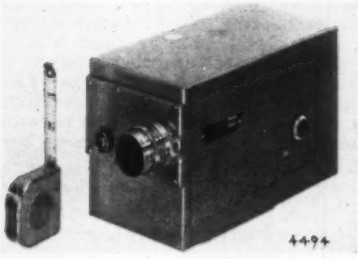


oscillographic recording systems; are adaptable to numerous recording requirements by means of interchangeable plug-in "front ends."—*Sanborn Co., Industrial Div., 195 Massachusetts Ave., Cambridge, Mass.*

For more information circle **208** on inquiry card.

Photographic Recorder

New "VDR-4" is designed for photopanel application or any other instrumentation problem where stop mo-

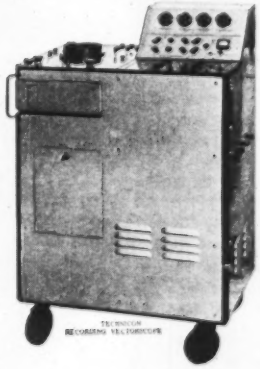


tion photography is required. Capacity 4000 individual 16-mm. pictures without reloading film.—*Vought Co., P.O. Box 1350, Beverly Hills, Calif.*

For more information circle **209** on inquiry card.

Electrophysiological Recorder

New "Recording Vectorscope" makes available oscilloscopic monitoring and recording of every known



ECG lead, or leads, in any combination; ballistocardiograms; heart sounds; pulse tracings; arterial or in-

THE WELCH DENSICHRON®

A Versatile Instrument for the Measurement of Reflectance and Transmittance

Makes Precision Light Measurements-Quickly-Accurately

The Welch Densichron is an electronic densitometer of good sensitivity and unusually high stability. It can be employed either for quantitative measurement of optical density, or as a sensing device for automatic control of various industrial processes in which constancy of transmitted or reflected light is a criterion of the quality or uniformity of the product.

It consists essentially of a probe unit containing a photoelectric tube for detecting light energy and an amplifier to which it is connected by a flexible cable. The amplifier incorporates a milliammeter calibrated to indicate either optical density on a "log" scale or percent transmission on a "linear" scale, depending upon the model.

Although the Densichron can be used in a wide variety of ways it is a simple device to use and requires no special operator skill. It will perform satisfactorily in routine operations for long periods of time with little or no servicing, yet is readily adaptable to innumerable types of special measuring techniques.

3830A. DENSICHRON WITH BLUE PROBE. This consists of the amplifier with logarithmic-scale meter, blue-sensitive probe, metal probe support, five different measuring apertures, a cone with ⅛-inch aperture, and a set of instructions. The amplifier operates on 115 volts, 60-cycle A.C., only, except on special order. **Each, $225.00**

3830B. DENSICHRON WITH RED PROBE. This is identical with No. 3830A except that a red-sensitive probe is furnished in place of the blue-sensitive probe. **Each, $225.00**

3832A. Reflection Unit **Each, $110.00**

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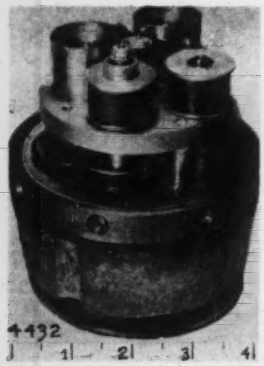
For more information circle **46** on inquiry card.

nique make it suitable for recording tracardiac pressures; in a great variety of cross combinations. Unit's high sensitivity and novel recording techlow-frequency non-repetitive transients in other fields.—*Technicon Cardiograph Corp.*, 215 *E.* 149, *New York* 51, *N. Y.*

For more information circle **210** on inquiry card.

Miniature Tape Recorder

New "Model MR-1" weighs 5 lbs. complete with all accessories including batteries and armor for ground im-

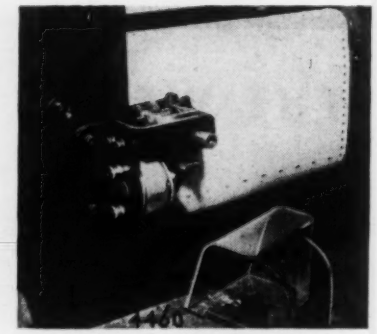


pact protection. Eight channels of information are applied to a ½-in. magnetic tape which runs at 1.5 ips. for 90 sec.; one channel for 400-cps. timing reference. Recorder will operate under axial accelerations up to 500 *G*, angular accelerations up to 200 radians/sec.^{2}, and axial spin rates up to 3000 rpm.—*North American Instruments, Inc.*, 2420 *N. Lake Ave., Altadena, Calif.*

For more information circle **211** on inquiry card.

Chart Identifier

New "Identichart" automatically prints a number, date or time on strip charts at instant when a voltage is applied; makes it easy for users to

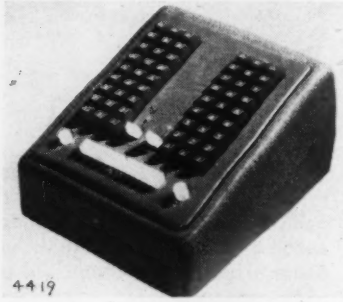


identify sections of charts in relation to particular conditions taking place at a remote point; mounts outside of recorder door regardless and does not interfere with or obscure recording procedure.—*Royson Engineering, Hatboro, Pa.*

For more information circle **212** on inquiry card.

X-Y Plotter Keyboard

New manually-operated decimal keyboard activates a plotter by supplying excitation for *X* and *Y* input

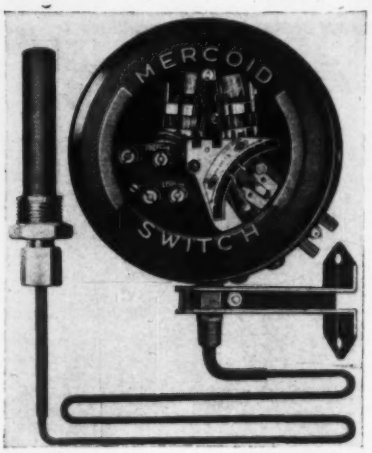


transducers. Innovation: elimination of problem of sticking switch contacts and high contact resistance. Self-wiping slide-type contacts, linked directly to keys, obviate need for any adjustments of switches and contacts.—*Librascope, Inc.*, 808 *Western Ave., Glendale, Calif.*

For more information circle **213** on inquiry card.

Temperature Controller

New 2-stage controller provides advantage of staged operation from a single actuating Bourdon tube. Two



independently adjustable magnetic mercury switches provide for successive-stage operation or high-low operation.—*Mercoid Corp.*, 4201 *W. Belmont Ave., Chicago* 41, *Ill.*

For more information circle **217** on inquiry card.

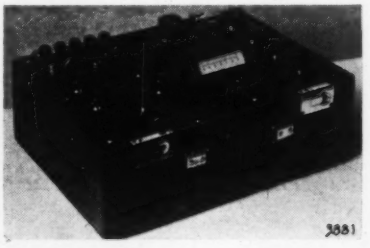
Safety Shut-offs

New "VS Temperature Actuated Safety Regulators," designed primarily for controlling vapor line in degreasers by shutting off steam and gas to heating coil if vapor exceeds a given level, can be used also as a safety control on other process industries applications. Feature: field-replaceable thermal system. Available in sizes ½ in. to 1½ in. Inlet pressure limit 100 psig.—*Farris Stacon Corp., Palisades Park, N. J.*

For more information circle **218** on inquiry card.

Potentiometer

New "Thermo-Voltage Compensator" (German-made) is a potentiometer said to be unique in that it utilizes



a continuous drain of standard cell. Maker's report: "Tests carried out over a period of months with saturated and unsaturated cells . . . show that when a current of 10^{-5} amp. is drawn from a standard cell it will maintain its voltage constant within satisfactory limits because with this very small current no exhaustion of the Hg ion concentration at the anode occurs."—*Donald C. Seibert, Box* 281, *Wilmington, Del.*

For more information circle **219** on inquiry card.

Plug-in Pilot & Valve

New plug-in pilot and gas valve combination is supplied unassembled, so that a small inventory of valves

TEMPERATURE

Remote Thermometer

New "Type 1460 Electric Thermometer" is multi-channel electric thermometer; simply hold down toggle switch representing temperature zone in which you are interested and read temperature. Uses any of standard "Alnor" thermo-bulbs; 50-circuit unit is only 20¾ x 10⅝ x 6 inches.—Many ranges available.—*Illinois Testing Labs., Inc.*, 420 *N. La Salle, Chicago* 10, *Ill.*

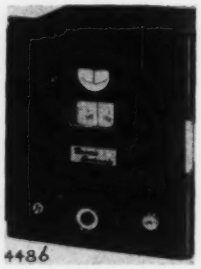
For more information circle **214** on inquiry card.

Fan and Limit Control

New "480" fail-safe combination fan-limit control is designed for gas, coal, or oil fired systems. "Super-safe" limit lever system checks every fan cycle. Both fan switch and the limit switch have fixed differentials and are actuated by a single thermal element which can be furnished in various lengths; features diaphragm actuator for both fan and limit, fully-enclosed dust-tight switches and summer settings for continuous fan operation.—*Perfex Corp.*, 500 *W. Oklahoma Ave., Milwaukee* 7, *Wis.*

For more information circle **215** on inquiry card.

Temperature Bridge



New "Manual-balance Indicator" makes null balance measurements for applications where speed of self-balancing bridge is not required. It is especially useful for directly reading temperature differences by use of two resistance bulbs connected opposed to each other (differences as small as 0.02 F. deg. can be measured). Turning knob to restore full adjusts slidewire and dial to temperature reading. Amplifiers have non-linear limiting action so that highest sensitivity is at balancing point.—*Thermo Electric Co., Inc., Saddle River Township, Rochelle Park P. O., N. J.*

For more information circle **216** on inquiry card.

It's in the Bag!

Fresh, Clean Ink for a Year of Trouble-free Recording

★ You won't have any messy, time-consuming re-inking of pens on the new Bailey Recorders. The entire system is white-glove clean—hermetically sealed, non-evaporating, non-corrosive. Gone is any chance of sludge or oxide formation. Gone are clogged pens, interrupted records, unsightly splashes.

The transparent plastic ink sacs are changed once a year—that's all. Capillary tubing carries fresh, clean ink to the pens continuously without any day-to-day attention.

This exclusive new inking system* is only one of the many time-saving, money-saving distinctive features of the new Bailey Recorder.

Ask for Product Specification E12-5.

*Now available for the New Bailey Recorder only.

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

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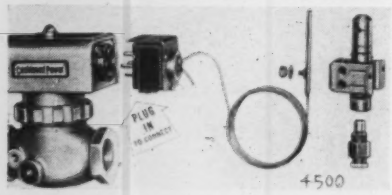
For more information circle **47** on inquiry card.

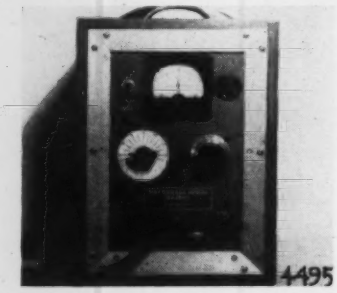


and pilot sub-assemblies will provide combinations to fill practically any gas-fired requirement; also permit quicker installation. In addition, new improved pilots are faster-acting and consume less gas (950btu.). Valves are recently-announced "Cushioned-Power" line.—*White-Rodgers Electric Co.*, 1209 *Cass Ave., St. Louis* 6, *Mo.*

For more information circle **220** on inquiry card.

Resistance Bridge

New "Type BU Speed Bridge" was developed to match maker's "Fuse-

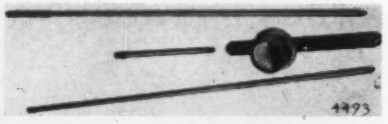


Din Resistance Thermometers" and other rapid primary elements. Temperature readings can be made as fast as time constant of primary element permits.—*Weiller Instruments Corp.*, 2 *Stone St., New York* 4, *N. Y.*

For more information circle **221** on inquiry card.

Hand Electric Thermometer

New "Model 191 Temprobe" weighs 22 oz., was developed for operations where frequent temperature checks must be made; consists of an indicator, two extension tubes, and one



air-temperature probe utilizing a thermistor. Extension probes permit effortless ceiling or floor level readings.—*Victory Engineering Co., Union, N. J.*

For more information circle **222** on inquiry card.

Triple Point Apparatus

New Triple Point apparatus (most accurate Temperature Standard known) comprises an evacuated vessel containing some high-purity distilled water. When dry ice is placed into central well, part of water distills into upper reservoir and freezes. This ice will then be always under the vapor pressure corresponding to O C. and its melting point is the International Fixed Point, more reliable than m-p. of ice in free air.—*Weiller Instruments Corp.*, 2 *Stone St., New York* 4, *N. Y.*

For more information circle **223** on inquiry card.

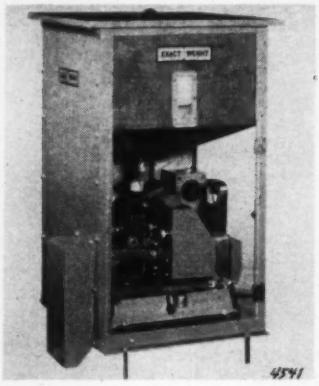
Glauber Salt Standard

New Glauber Salt Temperature Standard utilizes fact that sodium sulphate with ten molecules of water will crystallize out of solution with development of heat at 32.383 C. New Standard is assembled in a tube of insulating material with an embedded electric heater. Quantity of solution is sufficient to keep temperature constant for some two hours. Central well will admit 8-mm. thermometers.—*Weiller Instruments Corp.*, 2 *Stone St., New York* 4, *N. Y.*

For more information circle **224** on inquiry card.

Weigh Feeders

New injection-molding-machine weigh-feeders feature enclosed housing which eliminates contamination of

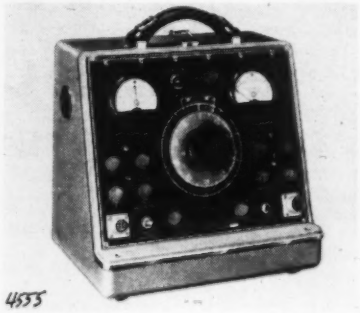


plastic moulding material. Four models are now available on which new enclosed housing can be installed.—*Exact Weight Scale Co.*, 944 *W. 5th Ave., Columbus, Ohio.*

For more information circle **227** on inquiry card.

Portable Strain Indicators

New "Type RS-20" strain indicator features resistance and capacitance balancing controls, making possible

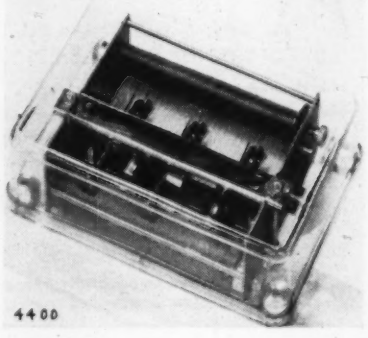


use of cables up to 500 feet long and eliminating need to add or subtract tare readings. Is available in 2, 6 or 12 channels. Operates with all types of pickups utilizing carrier excitation. Strain is indicated to an accuracy of one microinch per inch.—*Hathaway Instrument Co.*, 1315 *S. Clarkson, Denver* 10, *Colorado.*

For more information circle **228** on inquiry card.

Shock Recorder

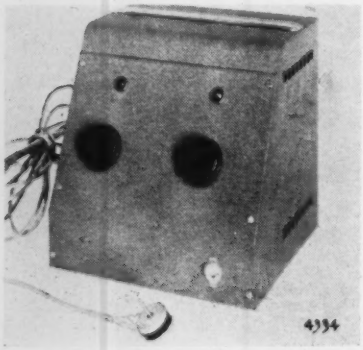
New models of "Impact-O-Graph" have been redesigned to give manufacturers and shippers of costly and/or fragile equipment a mechanical quality control medium. Attaching new small (6⅛ x 3½ x 2⅞ in.) lightweight



FORCE, LOAD, ETC.

Scale Remote Signal or Control System

New "Scale Monitor" permits weight or force to be read at a distance, can operate signal lights and open or close switches and solenoids;



features simplicity of design, maintenance, and operation, and an almost infinite range of settings. Essential parts: a voltage-divider pickup connected directly to scale pinion in rear of the scale, and a control box. These form a system similar to a Wheatstone Bridge.—*John Chatillon & Sons*, 85 *Cliff St., New York* 38, *N. Y.*

For more information circle **225** on inquiry card.

Force Pickups

New series of sensitive volumetric load-measuring elements measure tension, compression, or force, and indicate or record all measurements up to a maximum distance of 200 feet. Four types of elements are provided—spool, ring, diaphragm, and capsular. Ranges up to 250,000 lbs. for compression, and 30,000 lbs. for tension are available.—*Taylor Instrument Cos., Rochester* 1, *N. Y.*

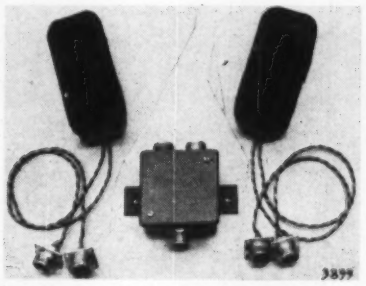
For more information circle **226** on inquiry card.

(22 oz.) model to product or shipment enables one to determine its serviceability in a few seconds. Paper-tape record shows magnitude of shock from longitudinal, lateral and vertical directions.—*The Impact-O-Graph Corp., 1900 Euclid Ave., Cleveland 15, Ohio.*

For more information circle **229** on inquiry card.

Rudder-pedal Dynamometer

New "R1040-3" is for measurement of rudder forces. Two are used in conjunction with a junction box, and maker's "Servometer." Each unit is a tri-

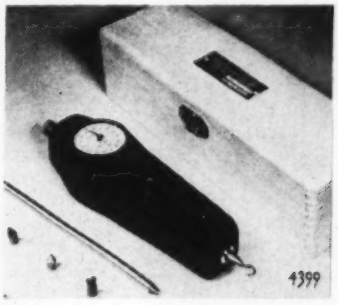


ple cantilever beam dynamometer employing two strain gage bridges, each with four active arms. (Original design work was by Wright Air Development Center.)—*Radiation, Inc., Melbourne, Fla.*

For more information circle **230** on inquiry card.

Force Indicator

New force indicator with 30-lb. capacity is shaped for easy hand operation or for use in permanent test set-

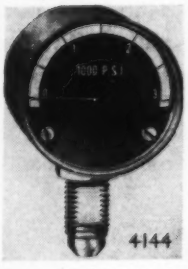


ups; comes with six stainless-steel attachments for measuring various linear and rotational forces; uses a compensated spring mechanism (gradient error 0.1 percent) and a "fully jewelled" dial indicator. Over-all accuracy 0.125 lb.—*Hunter Spring Co., Lansdale, Penna.*

For more information circle **231** on inquiry card.

PRESSURE

High-shock Gages



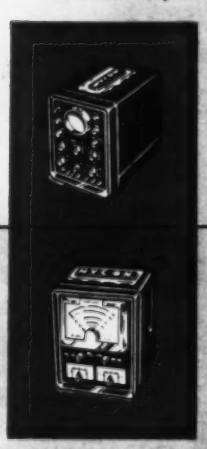
New "Glaser" pressure gages, originally developed for missile and rocket use, are of radically new design, withstand 50-*G* shock, 20-500-cps. 8-*G* vibrations, –120 F. to 300 F., corrosive atmospheres, etc. Accuracy is 0.25 percent. Sizes from 1½-in. (illustrated) to 6-in. Smaller sizes

ACCURACY
at a glance!

Just select the range you want... Hycon's new Model 615 *Digital* VTVM does the rest... gives you a *direct* reading in numerical form, complete with decimal point and polarity sign. There's no interpolation, no chance of reading the wrong scale. Even inexperienced personnel find the Model 615 easy to use... you just *can't* read it incorrectly!

Ideal for both laboratory and production-line testing, here's what the Model 615 offers...
...1% accuracy on DC and ohms; 2% on AC
...12 ranges... 0 to 1000 volts DC and AC; 0 to 10 megohms
...Illuminated 3-digit scale, with decimal point and polarity sign
...Response (with auxiliary probes) to 250 mc
...Shielded case; rugged, bench-stacking design; lightweight

Two more Hycon test instruments... designed for tomorrow's circuitry... *ready for color TV...*



MODEL 617 3" OSCILLOSCOPE...
Accurate enough for research, rugged enough for servicing. Features high deflection sensitivity (.01 v/in rms); 4.5 mc vertical bandpass, flat ±1 db; internal 5% calibrating voltage. **SPECIAL FLAT 3" CRT FOR UNDISTORTED TRACE FROM EDGE TO EDGE.**

MODEL 614 VTVM...
Maximum convenience combined with unprecedented low cost. Plus features include: 21 ranges (28 with p-p scales); 6½" meter; 3% accuracy on DC and ohms, 5% on AC; response (with auxiliary probe) to 250 mc. **TEST PROBES STOW IN CASE, READY TO USE.**

See these Hycon instruments ...all in matching, bench-stacking cases... at your local electronic jobber.

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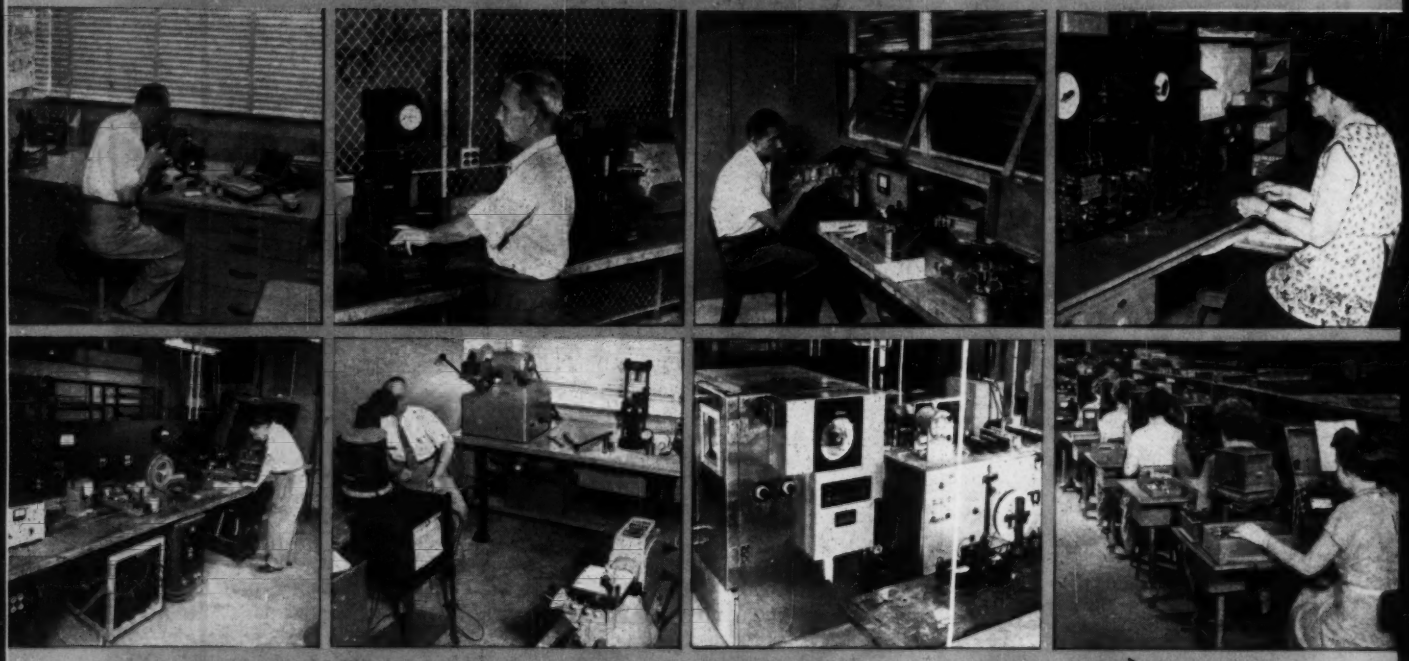
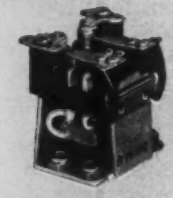
For more information circle **48** on inquiry card.

the secret of OHMITE® resistor RELIABILITY...



TESTING... TESTING... never-ending TESTING!

30th Anniversary 1938-1968



RELIABLE RELAYS, TOO!

When you need fast delivery on relays of highest quality, investigate AMRECON® general-purpose relays. They are available in current ratings up to 25 amp AC or DC (in all std. voltages); in a wide variety of contact arrangements; and with hermetically sealed or dust-protected enclosures.

WRITE FOR CATALOG AND DESCRIPTIVE BULLETIN R-10

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You can't afford the risk of failure in your equipment. Insist on components of proven reliability. In the modern Ohmite laboratories, Ohmite resistors are tested and retested under the most grueling conditions so that potential sources of trouble can be detected and eliminated. And, Ohmite is constantly searching for new materials, new processes, and new designs—to build Ohmite products that set new standards of long life and trouble-free performance.

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RHEOSTATS • RESISTORS • TAP SWITCHES

OHMITE MANUFACTURING COMPANY, 3615 Howard Street, Skokie, Illinois (Suburb of Chicago)

For more information circle **49** on inquiry card.

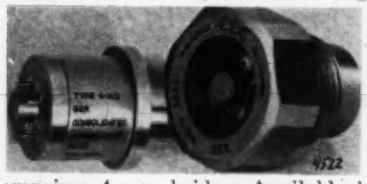
NEW INSTRUMENTS

feature direct drive of pointer by helix; larger sizes are geared. All are individually calibrated at factory.—*Designers for Industry*, 4746 *W. Washington Blvd., Los Angeles* 16, *Calif.*

For more information circle **232** on inquiry card.

Pressure Pickups

New "Type 4-313" and "Type 4-314" electrical-resistance-type pressure pickups are designed to measure gas and liquid pressures in higher ranges. Each pickup is 1 in. long;



comprises 4-arm bridge. Available in 1000, 2000, 3000, and 5000 psi ranges; other ranges available on special order.—*Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena* 15, *Calif.*

For more information circle **233** on inquiry card.

Pressure and Displacement Indicator

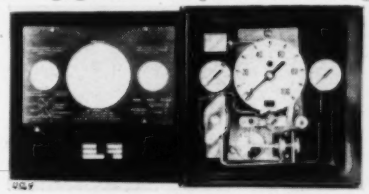
New "Model DG-400 Dynagage" is said to be a completely new model for measuring static and dynamic pressures and displacements "under the most adverse temperatures and vibrations." Has integral power supply, retains all features of original "Dyna-

gage" with size and weight reduced over 75 percent. ★Complete new series of pressure pickups for ranges to 75,000 psi.—*Photocon Research Products*, 421 *N. Foothill Blvd., Pasadena* 8, *Calif.*

For more information circle **234** on inquiry card.

Pressure Controller

New "K&M 54 Pressure Pilot" features a self-contained controlled pressure gage in a compact unit. Chang-



ing from proportional to differential gap control or from direct to reverse action involves only shifting turret-type nozzle from one position to another. Both proportional band and differential gap are adjustable from 1 to 100 percent. Features: all-metal relay, pneumatic feedback synchronization, full damping controls for surge pressures, and a sapphire feed orifice with pushbutton cleaner. Available separately, or mounted on standard K & M diaphragm control valves in control pressure ranges from 15 to 5000 psi.—*Kieley & Mueller, Inc., 151 Genung St., Middletown, N. Y.*

For more information circle **235** on inquiry card.

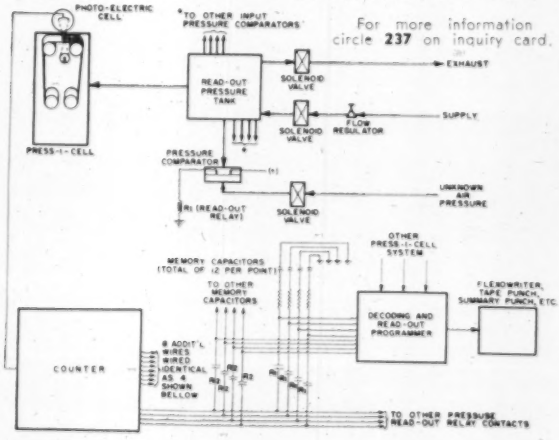
Pressure Controller

New Cartesian Manostat for industry, utilizing same principle as Cartesian Manostat brought out by maker for laboratories, will contain features which will permit its direct application to industrial processes, through an increase in capacity over present units, and addition of an integrating counter which will directly indicate pressure setting. Latter feature was developed by making instrument an absolute and differential type.—*Emil Greiner Co., 20-26 N. Moore St., New York* 13, *N. Y.*

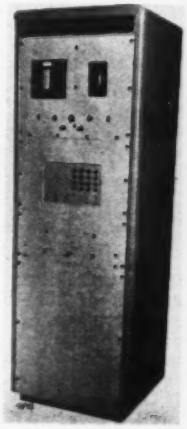
For more information circle **236** on inquiry card.

Pressure Readout System

New "F&P Multiple Pressure Readout System" makes it possible to measure up to 200 pressures at a given instant, and to read out digital values, accurate to 1 part in 2000, of all measured pressures within two minutes of time pressures are sensed; is automatically or manually tripped to begin a sensing and readout cycle; is fully enclosed and ready for connection to pneumatic inputs and power source.—*Fischer & Porter Co., 356 Jacksonville Rd., Hatboro, Penna.*

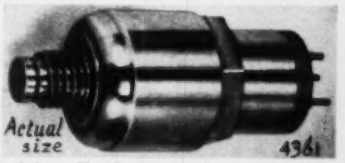


For more information circle **237** on inquiry card.



Pressure Pickups

New improved group of high-performance pressure pickups with ranges to 7000 psi. features pressure-



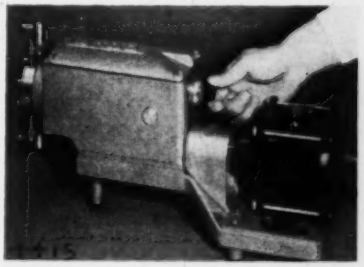
sensitive diaphragms ¼ in. in diameter. Natural resonant frequency approaches 20,000 cps. at higher ranges of pressure. For temperatures up to 4000 F., new ¼-in. unit can be used with maker's water-cooled adaptor. (Frequency response of pickup in adaptor is 3000 cps). Accuracy 0.5 percent at 70 F.—*Dynamic Instrument Co., Inc., 28 Carleton St., Cambridge, Mass.*

For more information circle **238** on inquiry card.

FLOW

Metering Pump

New "Microflo Pulsafeeder" achieves metering, feeding and proportioning of fluids at micro flow

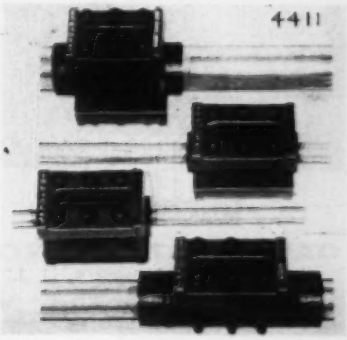


rates; is of piston-diaphragm type; will operate against pressures up to 1000 psi.; maximum flow rate of 2400 ml. per hour. Product is isolated from all pumping parts by a hydraulically balanced diaphragm and is kept safe from contamination and leakage to atmosphere.—*Lapp Insulator Co., Inc., LeRoy, N. Y.*

For more information circle **239** on inquiry card.

Sight Flow Indicators

New complete line of sight flow indicators, for viewing liquid flow in any new or existing pipe line ½ in. to 2 in. N.P.T., includes models in transparent two-window and one-window, and reflex one-window types. Visibility of liquid flow is enhanced by obtaining turbulence through interrupted bore



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a complete line of

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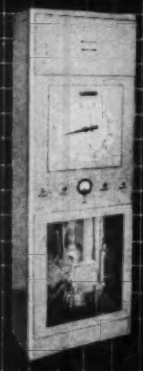
operating by catalytic combustion, electro-conductivity, thermal conductivity, and photochemical reactions.



Continuous ELECTRO-CONDUCTIVITY GAS ANALYZER

For the analysis of gases and vapors that ionize in water, directly or when decomposed by heat. Sensitive to small quantities.

Send for Bulletin 11-70

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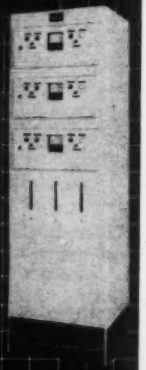

For the protection of life, property and processes against combustible gases and vapors in air. Gives audible and visual alarm signals.

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PHOTOCHEMICAL OXYGEN ANALYZER

Continuous measurement of oxygen in gaseous streams, 0-100 p.p.m. Outstanding for simplicity of operation, specific measurement of oxygen without interference from most other gases.

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INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS

80 Halleck St., Newark 4, N. J.

Progressive Manufacturers of Gas Analysis Instruments

For more information circle **50** on inquiry card.

NEW INSTRUMENTS

of fitting. Several types of indicating vanes can also be furnished. "Solid Wedge Type Illuminators," are available for use with new flow indicators. Two models: Explosion-Proof (UL Approved) and Standard.—*Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Massachusetts.*

For more information circle **240** on inquiry card.

TIME INTERVAL, SPEED, COUNT

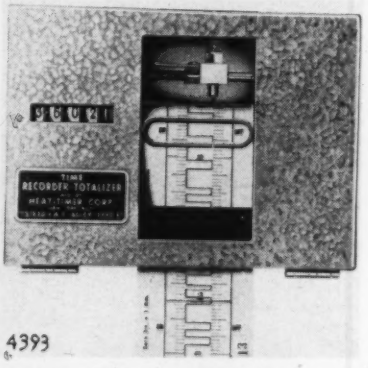
Time Delay Relay

New design of "Type A Silic-O-Netic" silicone-controlled time delay relay is available with standard timings from ¼ to 120 sec., features magnetomotive force considerably increased. This, and special spring loading of armature, has achieved high-speed contact action. Maker's hydraulic-magnetic principle, in which a silicone fluid is basis of delay, is retained.—*Heinemann Electric Co., 548 Plum St., Trenton 2, N. J.*

For more information circle **241** on inquiry card.

Time-operation Recorder

New model of maker's "Time Recorder + Totalizer" is available in

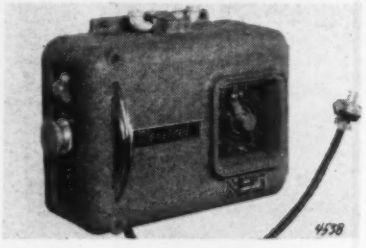


tape speeds of 1 in. per 5 min., per 15 min. and per hour.—*Heat Timer Corp., 657 Broadway, New York 12, N. Y.*

For more information circle **242** on inquiry card.

Process Timing Unit

New "Type D494A" is compact assembly of an automatic-reset electrical timer with solenoid valve, pushbutton

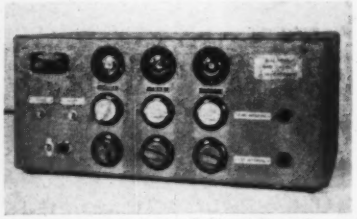


station, and signal light for timed operation of machines or processes. Pushbutton can be used also as emergency stop. Various time ranges available—seconds, minutes, etc.—*Emmett Machine & Mfg., Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.*

For more information circle **243** on inquiry card.

Cycle-repeat Timer

New "Model I.T." (Interval Timer) features two rows of selector switches: a dual timing circuit is possible e.g.

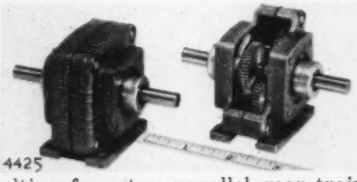


a filling operation of liquid and gas: liquid will flow 4 sec., shut off, gas will be drawn for 6 sec.; then timer shuts off and repositions itself to liquid station again.—*Electronic Products Div., Post Machinery Co., Beverly, Mass.*

For more information circle **244** on inquiry card.

Speed Reducers

New "Series 11," same size and about same weight as standard "Bantam" units, feature anti-backlash re-

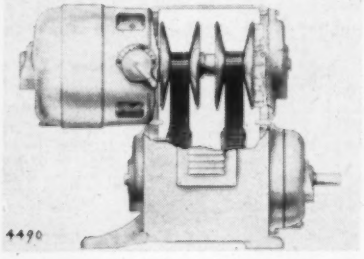


sulting from two parallel gear trains spring-loaded against each other, so that backlash is continuously taken up whether running or not.—*Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

For more information circle **245** on inquiry card.

Variable-speed Drive

New model of "Varidrive" motor has been upped to 60 hp. (Previously, top power limit was 50 hp.) Can also

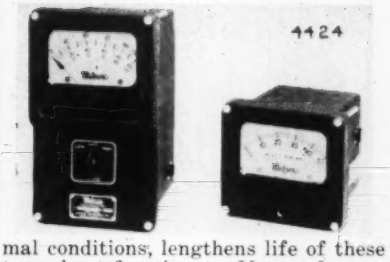


be equipped with remote controls, either mechanical or electrical—*U. S. Electrical Motors Inc., Box 2058, Los Angeles 54, Calif.*

For more information circle **246** on inquiry card.

Electric Tachometers

New models of maker's single-range and triple-range tachometers feature a redesigned circuit which, under nor-



mal conditions, lengthens life of these tacs about five times.—*Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

For more information circle **247** on inquiry card.

Frequency Counter

New "DS-6100-T" offers accuracy of 10 usec over frequency range of 1 to 10,000 events per second; also measures frequencies from 10,000 to 100,000 with accuracy of one count plus or minus one part in 100,000 (one

part in 1,000,000 with crystal ovens). Features: ten-cycle gage; batch counting; multi-sampling (manually scanning unknown frequency for any multiple of time base for greater accuracy).—*Computer-Measurements Div., Detectron Corp., 5528 Vineland Ave., N. Hollywood, Calif.*

For more information circle **248** on inquiry card.

Readout Counter

New high-speed (40 counts/sec.) pulse-actuated electromagnetic counter adds and subtracts, using separate

coils. "C-20-5 Series" have connected to each of 5 counter wheels a 0.5-watt pot which indicates visual number by a proportional voltage. "C-30 Series" have 10 electric contacts corresponding to numbers on wheels.—*Nemeth Inc., 2223 So. Carmelina Ave., Los Angeles 64, Calif.*

For more information circle **249** on inquiry card.

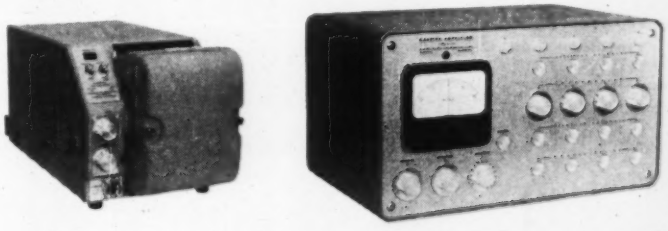
Two-way Counter

New counter not only adds but subtracts, is suitable for such operations as controlling flow of materials to

Stress-strain studies...
Dynamic machine analysis...
Vehicle road testing...
Medical recording...

Yes, these *general-purpose* instruments have done all four. Combining unusual versatility with top precision and economy, the 5-116 Recording Oscillograph and the 1-118 Carrier Amplifier are a compatible *team* as useful for engineering tests in the field as for research-laboratory demands. And, as an important extra, operation has been unusually simplified, with conveniences normally found only on the most expensive instruments. Both units are backed by Consolidated Engineering Corporation's nationwide engineering-service organization . . . your assurance of interruption-free test programs.

5-116 RECORDING OSCILLOGRAPH AND 1-118 CARRIER AMPLIFIER



5-116 RECORDING OSCILLOGRAPH—9 or 14 data channels with interchangeable galvanometers up to 3000 cps . . . 5" x 125-ft. records at speeds from ¼" to 100" per second . . . trace identification, 1/10 and 1/100-second timing lines, easy-load magazine and automatic record numbering . . . rugged, withstands most extreme environmental conditions. SEND FOR BULLETIN CEC 1521A-X3.

1-118 3-KC CARRIER AMPLIFIER—ideal for strain-gage work from static conditions to 600 cps . . . self-contained power supply provides 5 volts of carrier excitation . . . 4 separate channels with individual adjustments . . . 7 built-in calibration steps in convenient 2:1 ratio . . . continuous sensitivity control . . . full-scale output of 5 ma for 1.9 to 64-mv input. SEND FOR BULLETIN CEC 1522C-X3.

Either the 5-116 or 1-118 can be used with other recording and amplifying instruments. A CEC Field Engineer will be glad to discuss your testing requirements.

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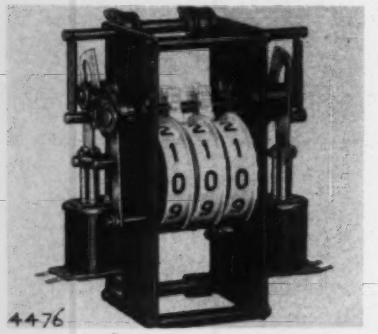
For more information circle **51** on inquiry card.

NEW INSTRUMENTS



machinery or conveyors, production and inventory, and control of physical capacity in areas. Max. rate 400 counts per minute, up or down. Can be set at a predetermined figure to automatically shut off at zero. Weight 2 lbs. 5 oz.—*Spencer Mfg. Co.*, 3253 *N. Cicero Ave., Chicago* 41, *Ill.*

For more information circle **250** on inquiry card.

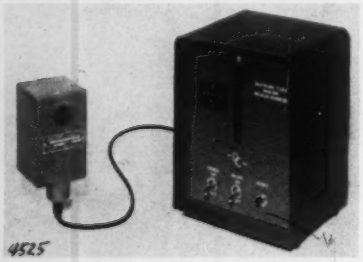
Electric Counter

New "Tab Electric Counter" features positive stepping for each impulse up to 300 counts per minute. Four-digit model is 1⅞ in. wide, 1⅜ in. deep, 2⅝ in. high; weighs about 6 oz.; 50 and 100 volts standard, other voltages special.—*Como Mfg. Corp.*, 5013 *N. Kedzie Ave., Chicago* 25, *Ill.*

For more information circle **251** on inquiry card.

Decade Counter

New "Model 345" features printed circuits and miniature high-speed mechanical register combined with one electronic decade; is capable of a sustained counting rate of 200 counts per

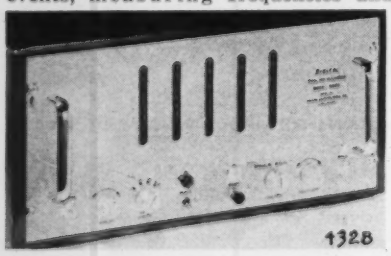


second. Count capacity of 1,000,000 makes unit suitable for a variety of industrial applications. Reset is instantaneous. Pulse pair resolution is 5 microseconds. Input impedance is one megohm.—*Daytronic Corp.*, 216 *S. Main St., Dayton* 2, *Ohio.*

For more information circle **252** on inquiry card.

Counter and Controller

New "Model N-655" five-bank digital cycling counter, for counting events, measuring frequencies and



speeds, etc., comprises input amplifier, shaping circuit, gating circuit for controlling flow of information into counting assembly. Counting time interval is supplied from an internal time base generator controlled by a temperature-compensated crystal. Dividers reduce intervals to 0.01, 0.10, and 1.00 sec. (on special order to 10.0 sec.). An accessory device permits presetting one or more counts, to control frequency or speed by presetting upper and lower limit.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **253** on inquiry card.

Electric Counters

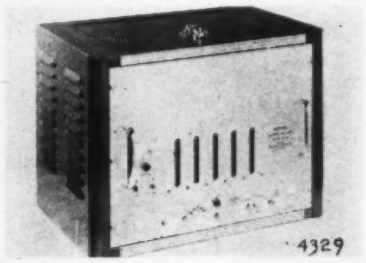
New "Super-Wizards" have an average life expectancy of 300 million counts; are rated at 1000 counts per

minute (1600 when suitable actuated). Available in "Basemount," "Panelmount" and "Dustproof" types for a.c. or d.c. to 230 v. in 4- and 6-digit models with knob or key reset.—*Production Instrument Co.*, 710-20 *W. Jackson Blvd., Chicago* 6, *Ill.*

For more information circle **254** on inquiry card.

Digital Counter-timer

New "Model N-955" combines functions of a digital cycling counter and a time interval meter; can produce

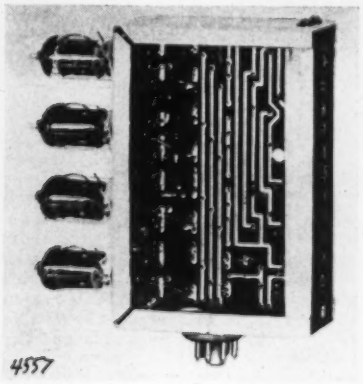


internally a precise gate length variable in decade steps from 0.001 sec. to 10 sec. Choice of automatic or manual operation. Frequency measurement feature. An accessory device permits presetting one or more counts.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **255** on inquiry card.

120-kc Decade Counter

New "Model AC-4A" decade counter units have 120-kilocycle counting rate and an output voltage suitable for



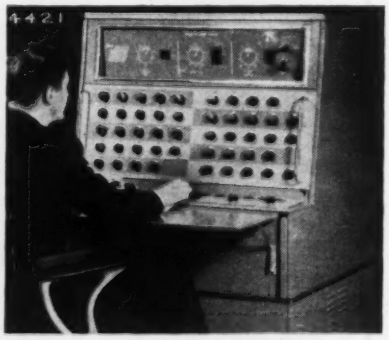
recorder operation. Features: fits all standard electronic counters, regardless of make; new etched circuits give good balance and uniform capacities.—*Hewlett-Packard Co.*, 395 *Page Mill Rd., Palo Alto, Calif.*

For more information circle **256** on inquiry card.

COMPUTING

Performance Computer

New "Aerolog" calculates steady-state rates of climb, maximum speeds, lift coefficients and climb angles of any

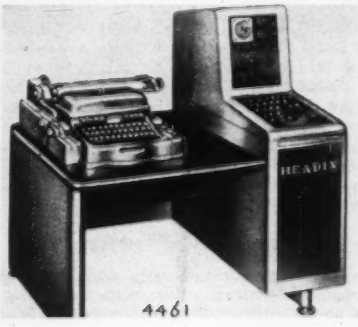


airplane; is unique in that it is suited for operation by aircraft design groups rather than requiring computer specialists.—*Link Aviation, Inc., Binghampton, N. Y.*

For more information circle **257** on inquiry card.

Digital Computer

New "Readix" general-purpose computer, said to "incorporate far-reaching advancements," is a decimal serial single-address machine with a magnetic storage capacity of 4000 words. Each word consists of 10 decimal digits with sign—or two commands, complete with addresses. Scaling of products or quotients can be accomplished



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This unusually accurate instrument was originally designed to be used in Midwestern's Galvanometer Shop for precision calibration. It was so extremely valuable there we are now making it available for commercial sale. It is a finely-regulated dc power supply, with unusually small ripple content, operated in conjunction with a network of precision, temperature-stable resistors. Output is controlled by a 10-turn precision potentiometer in the bias circuit of the electronically-regulated power-supply section. A highly accurate voltmeter measures voltage across the precision resistor and output load network, and is calibrated in terms of current.

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- TORQUE MOTORS
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- DATA REPEATERS
- WATERPROOF CONNECTORS
- GEOPHYSICAL EQUIPMENT

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41st and Sheridan Road — Tulsa, Oklahoma

For more information circle **52** on inquiry card.

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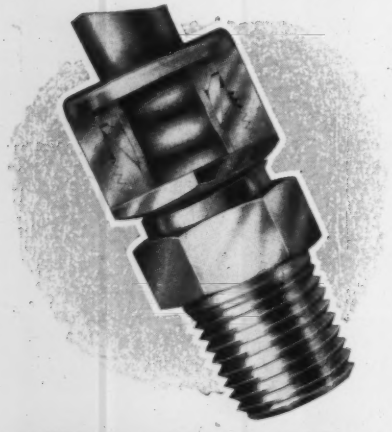

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For more information circle **53** on inquiry card.

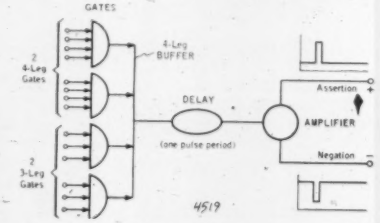
NEW INSTRUMENTS

by a simple shift command. The six operations of arithmetic are performed by a single command. Alphabetical material can also be stored and sorted.—*J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, California.*

For more information circle **258** on inquiry card.

Unitized Gating Circuit

New "3C-PAC Gating Package" is high-speed digital building block. Operating at one-megacycle repetition rate, unit can be made to perform endless variety of logical operations and

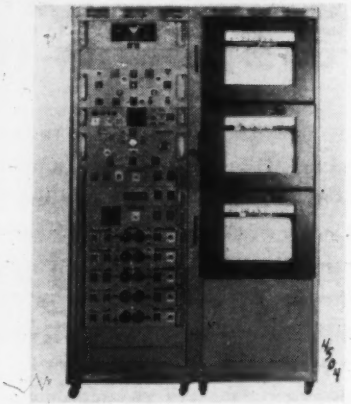


computations. Consists of two 4-leg gates and two 3-leg gates joined by a 4-leg buffer, a lumped delay, and an amplifier that produces both positive and inverted pulse trains. Any logical function of three variables (using the connectives "not, and, or") can be handled with this package. Many complex functions of four or more variables also can be implemented.—*Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.*

For more information circle **259** on inquiry card.

Computing Plotter

New "Plottomat" automatically plots and integrates values of any combination of parameters: takes minutes



where conventional manual methods require weeks; can be adapted to existing card punch systems; or data may be fed into IBM or UNIVAC calculators.—*Allied Engineering Div., S. Norwalk, Conn.*

For more information circle **260** on inquiry card.

Data Processor

New "Univac File-Computer" introduces fast random access and multiplex monitoring to standard electronic data processing systems, meets demand for an intermediate size alphabetical and numerical data processing system. In an eight-hour day, up to 100,000 unsorted items can be entered in their order of arrival, each matched automatically with its related file data, and processed as needed. In control of raw materials and components it makes available for the first time an electronic method of recording inventory data without need for prearrangement of data in numeric sequence. As many as 24 input units can be handled at the same time. Magnetic drum techniques on which new system is based were pioneered by Engineering Research Associates Div. —*Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.*

For more information circle **261** on inquiry card.

Function Generator

New "Model DEFG-201 Mod I" five-channel diode electronic function generator is said to be "capable of generating a function of two variables more swiftly and with greater precision than any other analog computer equipment previously offered." Functions are generated by straight line segments which may be in quadrants I, II, III or IV. Feature is new diode circuit which makes each individual segment adjustment independent of every other adjustment. Forty line segments are available, flexibly arranged so that they may be distributed in various combinations among the five channels. Break points of diode segments can be made a function of second variable, so that device can be used to generate a function of two variables $f(x,y)$.—*Reeves Instrument Corp., 215 East 91st St., New York 28, N. Y.*

For more information circle **262** on inquiry card.

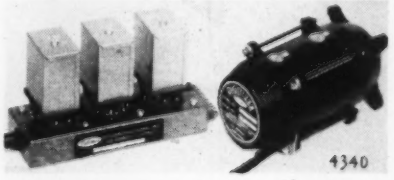
Computing Recorder

New "Electrographic Recording" will print calculations of an electronic computer at rate of 5,000 characters per second. Characters first take form of a pin-point pattern of electrostatic charges on surface of a coated paper. Next, pattern is made visible by passing paper through a dry ink bath; tiny particles of powdered ink cling to pinpoint areas where paper has been charged. Paper rolls through a third station where a hot plate "fixes" the ink permanently. Paper moves at steady speed up to 44 fps. End result is a line of uniform printed characters with virtually no background discoloration.—*Burroughs Corp., Detroit 32, Mich.*

For more information circle **263** on inquiry card.

Binary Digitizers

Two new electromechanical "Digitizers" convert shaft rotation into 10- or 15-bit straight parallel binary output; can be attached to servo systems, self-balancing potentiometers, etc., to automatize recording of pressure, temperature, strain, voltage, shaft or lead-screw position, etc. Among features:

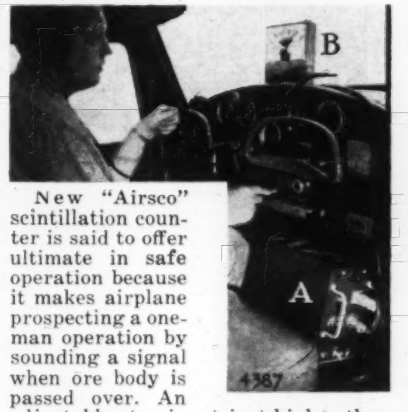


(1) high signal contact output (rated 250 ma. at 40 v.dc.); (2) brushes and contacts can be separated during rotation of shaft, virtually eliminating brush wear and reducing torque to 0.01 oz.-in.; (3) high-speed slewing at rates to 12,800 counts per second; (4) extending life indefinitely by replacement of contact-making components. "Model P10D" total capacity 1023 counts in 16 revolutions of input shaft; "Model P15D" 32,767 counts in 512 revs. Digitizing unit which effects brush selection comprises three telephone-type plug-in relays in a chassis (furnished with each binary commutator).—*Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif.*

For more information circle **264** on inquiry card.

NUCLEONICS

Airborne Counter

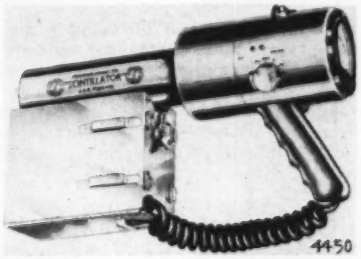


New "Airsco" scintillation counter is said to offer ultimate in safe operation because it makes airplane prospecting a one-man operation by sounding a signal when ore body is passed over. An adjustable stop is set just higher than background. Amplifier and probe assembly (A) is shock-mounted in out-of-the-way place; is operated from remote control box (B).—*The Goldak Co., 1539 W. Glenoaks Blvd., Glendale 1, Calif.*

For more information circle **265** on inquiry card.

Survey Meter

New "Model 111B Scintillator" features a "special percent meter which, for the first time in the development



of uranium location equipment, will make it possible to determine percentage of uranium in ore at the point of discovery."—*Precision Radiation Instruments, Inc., 4223 W. Jefferson Blvd., Los Angeles 16, Calif.*

For more information circle **266** on inquiry card.

Survey Meter

New "Tattler," for uranium prospecting, weighs 3 lbs.; features: self-contained transistor-amplified loud-

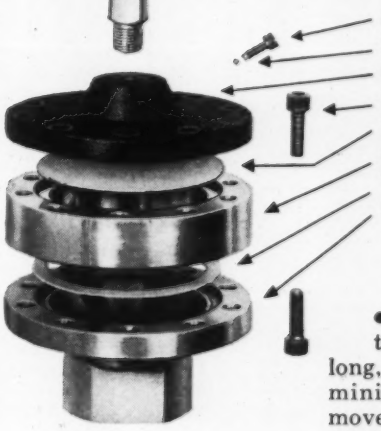
an ACCO product

Helicoid Chemical Gage

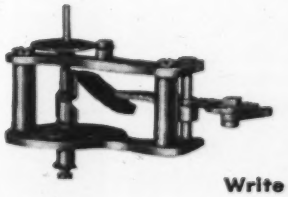
Gages for corrosive chemicals and liquids up to 5000 p.s.i.

• Here's an accurate pressure gage for chemicals and other viscous liquids which might corrode or clog the Bourdon Tube. It registers working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. Guaranteed accuracy plus or minus 1%. A single diaphragm seals off objectionable substances from the indicating gage. This gage is filled completely with specific inert liquids and pressure is transmitted directly to the indicating gage through deflection of the sealing diaphragm.

FEATURES



• HELICOID GAGES cost less in the long run because they give long, trouble-free service with a minimum of maintenance. The movement is a simple cam and roller design that does not have any gear teeth to wear out. It has been tested and proved in years of hard service.



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For more information circle **54** on inquiry card.

NEW INSTRUMENTS

speaker which can be regulated for pitch; ease of Geiger tube replacement; improved regulated high voltage supply. Four ranges of sensitivity, from low background to extremely "hot" intensity.—*The Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.*

For more information circle **267** on inquiry card.

Radiation Detector

New lightweight portable probe which selectively detects alpha-beta-gamma and thermal-neutron radiation features interchangeable heads for de-

tecting different radiations, extremely high thermal neutron counting efficiency, and ability to count alpha particles in presence of high beta-gamma background. Scintillation counter (basic detecting unit) contributes to high over-all efficiency, fast response time, and long life.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **268** on inquiry card.

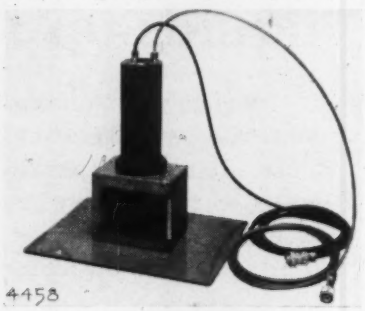
Decade Scaler

New "Model 181," for use with Geiger-Muller or scintillation detectors, has 5-usec. resolving time, permitting extremely precise measurement of radioactivity. Three 5-usec. decade circuits and a built-in register for determining total count during a specific time interval. Scale selector switch for choice of scaling factors of 10, 100 or 1000. A 60-cps. test signal is provided to check proper operation of plug-in decades; one lever resets register and scaling stages after a count is completed.—*Nuclear-Chicago, 229 W. Erie St., Chicago 10, Ill.*

For more information circle **269** on inquiry card.

Scintillation Counter

New alpha scintillation counter has background as low as 3 counts/hour while accepting samples up to 2 in.



diam. Alpha particles first strike a zinc sulphide equipped light pipe optically coupled to phototube. Output of two-stage amplifier can feed into any standard scaler.—*Radiation Counter Labs., Inc., 5122 W. Grove St., Skokie, Ill.*

For more information circle **270** on inquiry card.

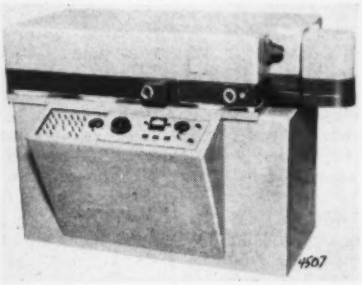
Scaler and Rate-meter

New "Model B-1800R" is a new instrument combination of a completely automatic scaler and a count-rate meter: complete electronic facilities for a research laboratory using radioisotopes, in a 16¼ x 23½ in. space and at "greatly reduced cost."—*NRD Instrument Co. (formerly Nuclear Research and Development) 6425 Etzel Ave., St. Louis 14, Mo.*

For more information circle **271** on inquiry card.

Automatized Analytical Spectrograph

New "Quantograph," said to be "new instrumental concept in spectrochemistry," combines features of a spectrograph, a monochromator, and

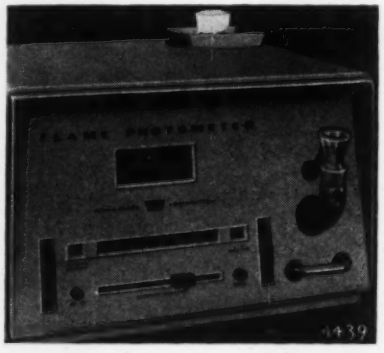


maker's "Quantometer"; performs complete functions of each. It embodies three methods of spectrochemistry: photography of spectra for complete analysis, polychromatic spectrometry for direct-reading quantitative analyses, and monochromatic spectrometry for qualitative and quantitive analyses.—*Applied Research Labs., Glendale, Calif.*

For more information circle **274** on inquiry card.

Flame Photometer

New "Model 146" embodies improvements to permit simple and precise readout of data, enabling a relatively inexperienced operator to turn out accurate determinations over long periods with minimum fatigue. All controls designed and positioned for maximum convenience. Data are read out

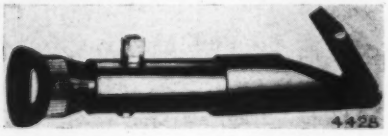


on counters instead of vernier dials. Duo-prism monochromator provides maximal discrimination between elements and the most rapid selection of wavelengths of all elements that emit in a gas flame.—*The Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **275** on inquiry card.

Pocket Refractometer

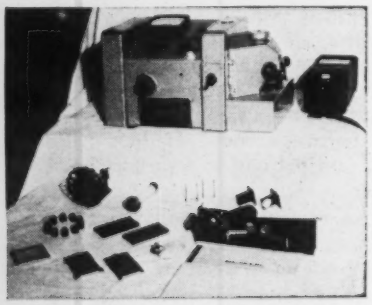
New pocket refractometer is said to make percent total solids in liquid extracts determinable "in half the time." It featupres a temperature compensating mechanism that obviates need for thermometers or conversion tables: user reads results on an illu-



LABORATORY

Colorimeter Accessories

New accessories for use with "Model C Color-Eye" difference colorimeter (abridged spectrophotometer) in-

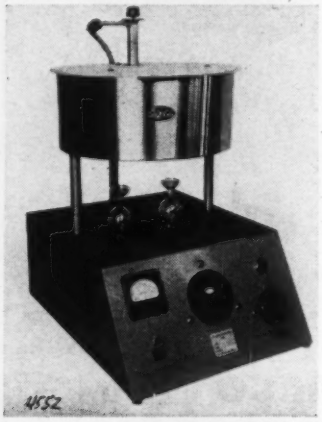


clude: New viewer attachment to permit visual inspection of samples exactly as they are presented to optical system of "Color-Eye"; a pair of neutral density filters; a series of sample holders for paint, plastics, and textile industries.—*Instrument Development Labs., Inc., 163 Highland Ave., Needham Heights, Mass.*

For more information circle **272** on inquiry card.

Saybolt Viscosimeter

New high-temperature Saybolt Viscosimeter determines viscosity of asphalts, road oil, and fuel oils at test



temperatures from 100 to 475 F. Bath in viscosimeter is solid aluminum block equipped with heaters; is drilled to accommodate two standard Saybolt tubes.—*Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.*

For more information circle **273** on inquiry card.

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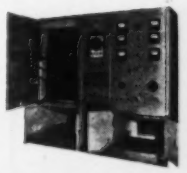
IN GOVERNMENT

Naval Research Laboratory

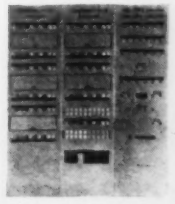
Los Alamos Physics Laboratory



McClellan Air Force Base

Aberdeen Proving Grounds

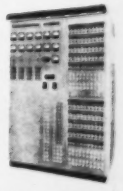
Naval Air Development Station



Frankford Arsenal

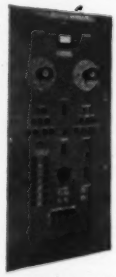
Pensacola Naval Air Station

White Sands Proving Grounds



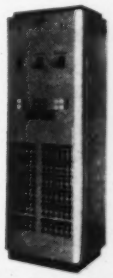
Naval Research Laboratory

IN SCHOOLS and UNIVERSITIES



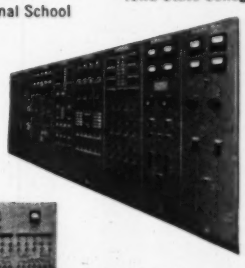
Bell Vocational School

Bell Vocational School

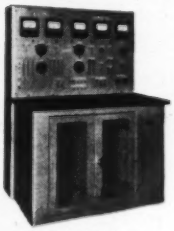


Iowa State College

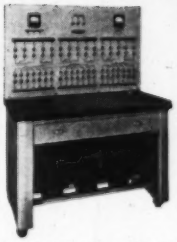
Princeton University



Bergen County Vocational School

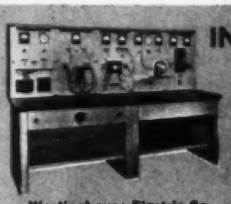


Technical School



Bell Vocational School

IN INDUSTRY and RESEARCH

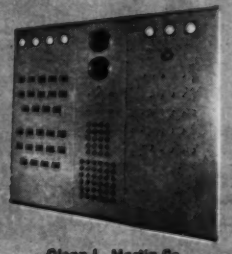


Westinghouse Electric Co.

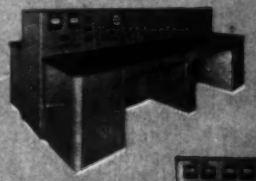
Monsanto Chemical Co.

Ford Motor Co.

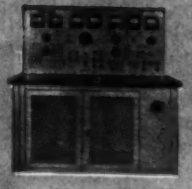
Radio Corp. of America



Glenn L. Martin Co.



Commonwealth Edison



Packard Motor Co.

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STANDARD *flexlab*

Since 1884

THE STANDARD ELECTRIC TIME COMPANY

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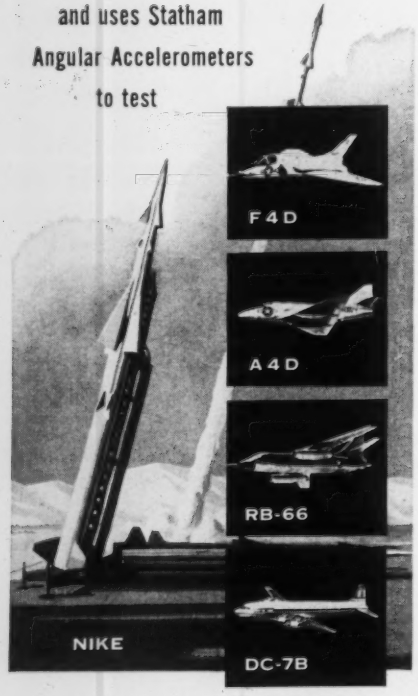
ELECTRIC CLOCK AND PROGRAM SYSTEMS • FIRE ALARM SYSTEMS • HOSPITAL SIGNAL SYSTEMS
PRECISION TIMERS • CHRONO-TACHOMETERS • PIPELINE NETWORK ANALYZERS

For more information circle **55** on inquiry card.

Do you think about Angular Acceleration?

DOUGLAS does...

and uses Statham Angular Accelerometers to test



Statham unbonded strain gage liquid rotor angular accelerometers offer a simple, reliable means for the study of the rotary motion of a test body under conditions where a fixed mechanical reference is not available. For static and dynamic measurements in ranges from ±1.5 to ±3,000 rad/sec², four standard models are offered.

Please request Bulletin AA2

Statham
LABORATORIES
LOS ANGELES 64, CALIFORNIA

For more information circle **56** on inquiry card.

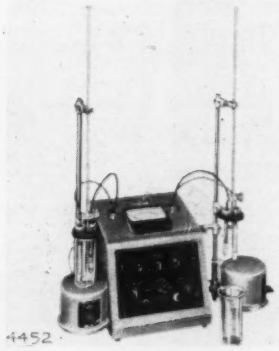
NEW INSTRUMENTS

minated scale. Three types: 0-30, 30-60 and 50-80 percent.—*National Instrument Co.*, 5005 *Queensbury Ave., Baltimore* 15, *Md.*

For more information circle **276** on inquiry card.

Dual Titrometer

Newly redesigned "Precision-Shell Dual Titrometer" provides greater sensitivity, wider range and easier



operation than older model; is applicable to a wide range of opaque and highly colored solutions; also suitable for ASTM D 664 and D 939. Sensitivity: it responds to an electrode current of the order of 10^{-13} amps.—*Precision Scientific Co.*, 3737 *W. Cortland St., Chicago* 47, *Ill.*

For more information circle **277** on inquiry card.

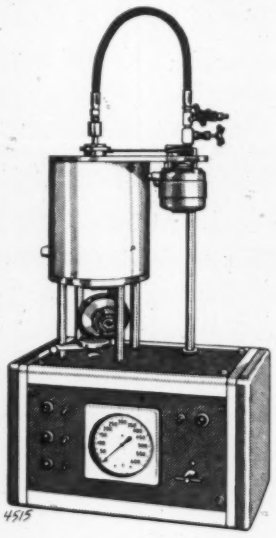
Titration Stand

Newly redesigned "Senior Titra-Lite" provides soft, evenly diffused "daylight" illumination for titration burettes and flasks; features "Full-View" burette clamp.—*Precision Scientific Co.*, 3737 *W. Cortland St., Chicago* 47, *Ill.*

For more information circle **278** on inquiry card.

Rheometers

New "Castor-Severs Extrusion Rheometers" are used for measurement of viscosity at high rates of flow. Various models permit operation at pressures up to 5000 psi. Reproducible accuracy



is obtained from 1 centipoise to over 5 billion centipoises.—*Burrell Corp.*, 2223 *Fifth Ave., Pittsburgh* 19, *Penna.*

For more information circle **279** on inquiry card.

Lab Detergent

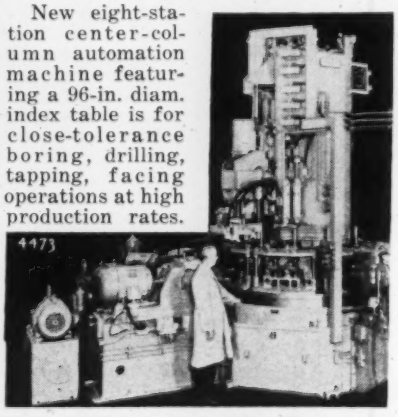
New "Alcowet" is detergent designed for use in laboratory washing machines and all mechanical washers; removes difficult stains and prevents spotting of glassware caused by quick machine drying operations, long a problem in machine washing.—*Alconox, Inc., Jersey City, N. J.*

For more information circle **280** on inquiry card.

SHOP AND AUTOMATION

Automation Machine

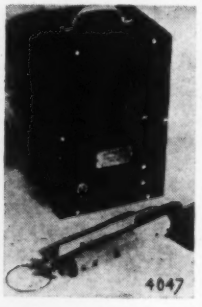
New eight-station center-column automation machine featuring a 96-in. diam. index table is for close-tolerance boring, drilling, tapping, facing operations at high production rates.



Machine fixtures are of sufficient size to permit mounting two medium-sized production parts in each fixture and processing two parts at one time at each station. Illustration does not show entire machine.—*Snyder Tool & Engineering Co.*, 3400 *E. Lafayette Ave., Detroit* 7, *Mich.*

For more information circle **281** on inquiry card.

Hot-wire Glass Cutter



New unit cuts soft or hard glass tubing up to 150 mm. diam. Power supply has a continuously variable a-c. voltage from 0 to 20 at 7.5 amps. Handle holds wire and pulls it taut around glass.—*Ronar, Inc.*, 1316 *Sherman Ave., Evanston, Ill.*

For more information circle **282** on inquiry card.

Hose-assembly Machine

New "Model 332" hose assembly machine, for rapid and easy make-up of "Hoze-lok" fitted hydraulic hoses, turns fitting socket, by means of a power-driven spindle, quickly onto hose and similarly nipple is screwed into socket. Operator can control speed when assembling fitting onto hose. Machine can be run in either direction: for detachment as well as assem-

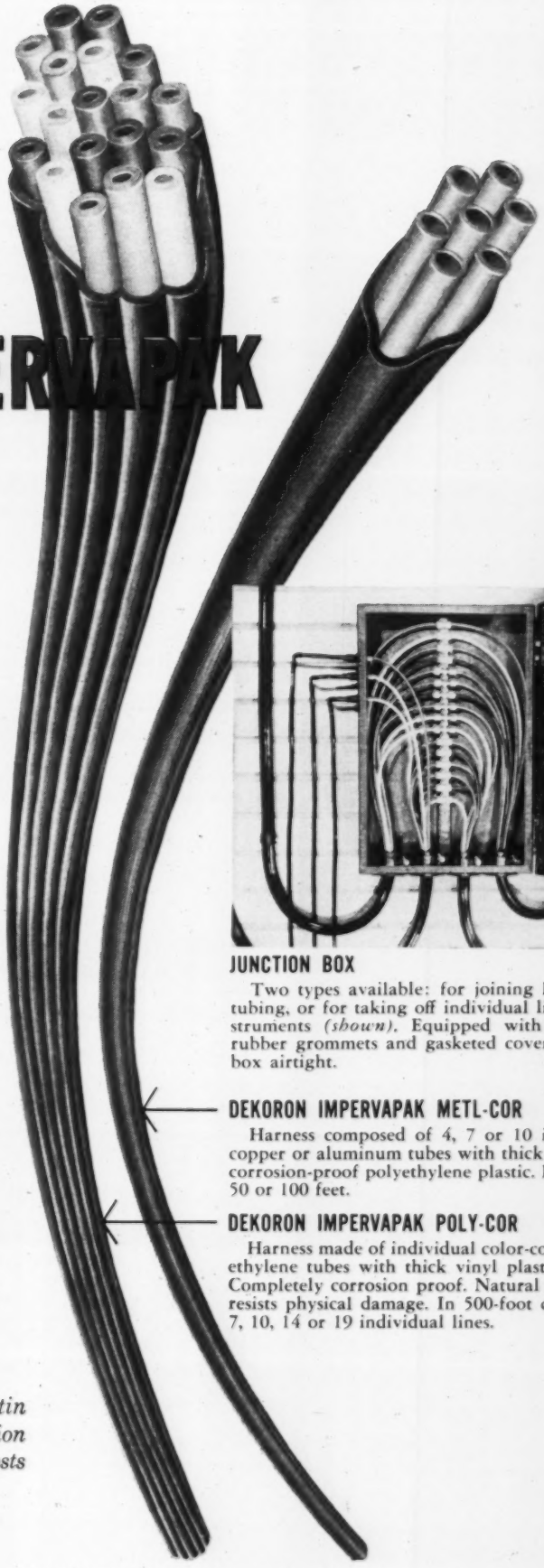
DEKORON IMPERVAPAK

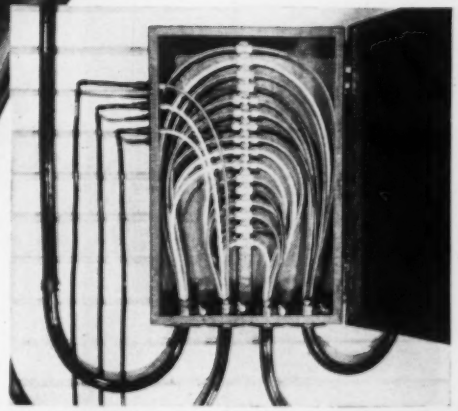
the instrument line harness that cuts tubing installation costs up to 80%

Worried about high instrument tubing installation costs? Then Dekoron Impervapak—the chemically resistant instrument tubing harness—is just what the cost analyst ordered.

With Dekoron Metl-Cor or Poly-Cor you don't laboriously install instrument lines one at a time. As many as 19 tubes can be installed at one handling—that's why users report that Metl-Cor cuts costs up to 60%, Poly-Cor up to 80%. Compact construction further reduces racking costs, looks neater and resists mechanical damage.

And perhaps most important of all, *Dekoron Impervapak is impervious to attack from even the most severe industrial atmospheres or weather conditions.* AA-744





JUNCTION BOX

Two types available: for joining lengths of tubing, or for taking off individual lines to instruments *(shown)*. Equipped with synthetic rubber grommets and gasketed cover to make box airtight.

DEKORON IMPERVAPAK METL-COR

Harness composed of 4, 7 or 10 individual copper or aluminum tubes with thick sheath of corrosion-proof polyethylene plastic. In coils of 50 or 100 feet.

DEKORON IMPERVAPAK POLY-COR

Harness made of individual color-coded polyethylene tubes with thick vinyl plastic sheath. Completely corrosion proof. Natural resiliency resists physical damage. In 500-foot coils of 4, 7, 10, 14 or 19 individual lines.

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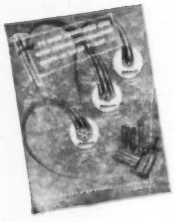


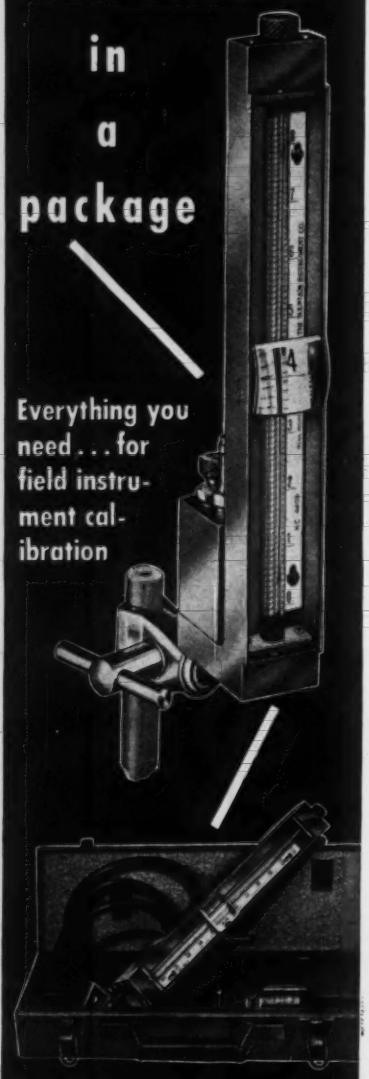
Send for your free copy of Bulletin L-6506 "3 Ways to Whip Corrosion and High Tubing Installation Costs in Your Plant."

For more information circle 57 on inquiry card.

UNMATCHED ACCURACY

in a package

Everything you need... for field instrument calibration



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★ Magnifying sight glass
★ Mirror for resolving parallax
★ Built-in level indicator
★ Precision-bore pyrex tubing
★ Built-in fluid seal
★ All stainless steel construction

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Meriam Manometer Instrumentation ...for pressures, vacuums, flows, liquid levels.

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10920 Madison Ave. • Cleveland 2, Ohio

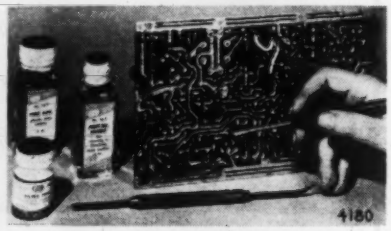
For more information circle **58** on inquiry card.

bly of re-usable fittings. Its weight is approx. 585 lbs.—*Tube & Hose Fitting Div., The Parker Appliance Co.*, 17325 *Euclid Ave., Cleveland* 12, *Ohio.*

For more information circle **283** on inquiry card.

Graphic-circuit Repair Kit

New "G-C Printed Circuit Repair Kit" is claimed to meet all graphic circuit servicing needs on virtually

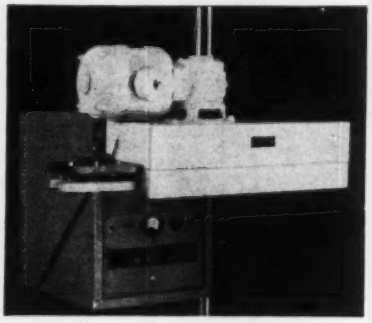


all TV sets using that circuitry; includes necessary silver print material and silicone resin for protecting silver coating, plus special tools and full instructions.—*General Cement Mfg. Co., 919 Taylor Ave., Rockford, Illinois.*

For more information circle **284** on inquiry card.

Bag-top Welder

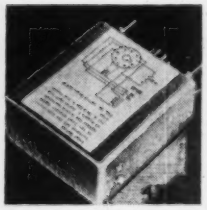
New "Model 525 Ectrotherm Continuous Electronic Bag-Top Welder" is an automatic high-speed closure



apparatus capable of integration into a packaging production line or coordination with automatic filling equipment. Bag speeds available: 30 to 60 fpm.—*Electronic Processes Corp., 1137 San Antonio Road, Los Altos, Calif.*

For more information circle **285** on inquiry card.

Plug-in Circuits

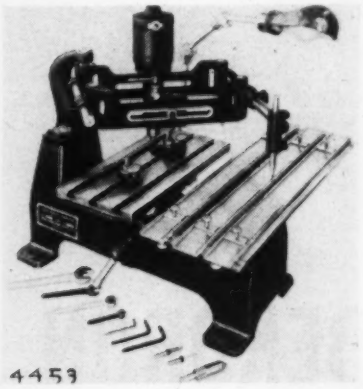


New plug-in circuits for automation comprise power supplies, load relays and automatic interrupters. "1817-2 Load Relay" (illustrated) contains a 5-ma. relay, 200 uf. timing capacitor and limiting resistor; a 9-pin octal-type plug; four hold-down screws. S-p.d-t. snap action contacts rated 5 amps., 115 v.ac. Other load relays have coils for 6, 12, 24, and 75 volts.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **286** on inquiry card.

Engraving Machine

New "Model UE-3" of maker's "Panto" features: increased number of pantograph reductions, a total of



21 sizes marked on bars; all bearing seats and other critical parts precision honed; 26-in. interchangeable copy table and 26-in. single slide which can be attached to 18-in. copy holder units; spindle speeds increased to 15,000 rpm.; new flexible machine lamp.—*H. P. Preis Engraving Machine Co., 156 Industrial Branch, Hillside, N. J.*

For more information circle **287** on inquiry card.

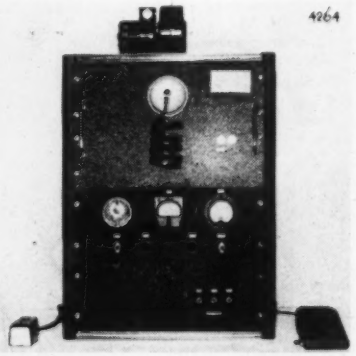
Auto-feed Polishing and Deburring Machine

New "Smooth-O-Matic" automatic-feed machine for polishing and deburring metal is said to be "the only self-feed low-cost machine available to the metalworking industry that produces desired results while greatly reducing production time."—*Timesavers, Inc., P. O. Box L, Minneapolis* 22, *Minn.*

For more information circle **288** on inquiry card.

Heating and Sealing Unit

New "DH122," designed for sealing of plastics, can be used wherever a strong radiofrequency field is needed for dielectric heating, as on automatic

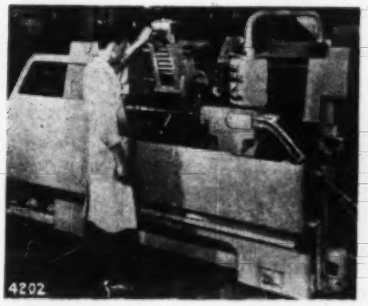


machines in packaging, dehydration, and instantaneous drying. Selection of four different power levels (by front-panel switching) permits optimum heating and prevents flash-over due to excess r-f. voltage. Power supply conservatively rated at 1600 watts continuous duty. Safety interlocks protect operating personnel.—*Scientific Specialties Corp., Snow and Union Sts., Boston* 35, *Mass.*

For more information circle **289** on inquiry card.

Copying Lathes

New "Pilot" automatic copying lathes copy-turn automotive transmission parts in 50 seconds to tolerance

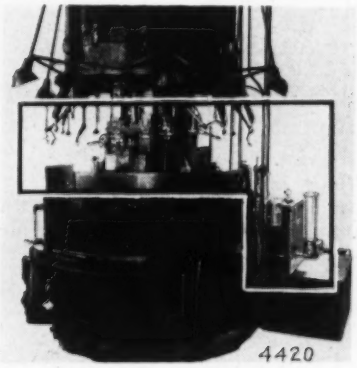


of 0.001-in. Rigidity of machines and novel hydraulic feed are said to result in tool life and finish previously unobtainable at such high cutting speeds in continuous production. One man can handle three machines.—*H.E.B. Machine Tools, Inc., 475 Fifth Ave., New York 17, N. Y.*

For more information circle **290** on inquiry card.

Lubrication System

New air-operated centralized lubrication system provides automatic ap-



plication of fluid lubricants to bearings on individual industrial machines at predetermined intervals; fulfills needs of automated machine lines.—*Lincoln Engineering Co., 5701 Natural Bridge Ave., St. Louis 20, Mo.*

For more information circle **291** on inquiry card.

Drilling Machine

New "Model 24" automatically locates and drills holes up to ½-in. diam. on a wide variety of work up to 24x48 in. or longer; is equipped with an adjustable-speed drilling unit (275

for **reliable performance...**

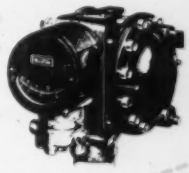
under field and plant conditions...

BARTON METERS | *offer:* High accuracy—rugged construction—simple operation inexpensive installation and very low maintenance...

for: the oil, gas and petrochemical industries.

For further information request bulletin 11C-4 or contact BARTON sales engineers, located in most principal cities.

MODEL 214
DIFFERENTIAL PRESSURE RANGES FROM 20" W. C. TO 400" W. C.
S.W.P. TO 4500 P.S.I.
3 TO 15 P.S.I. OUTPUT



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For more information circle **59** on inquiry card.

BEAT THE PRODUCTION LINE CLOCK WITH ALPHA's *mighty midgets**

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Designed and manufactured to your specific requirements.

For use with flame, oven or induction heating. Preforms speed automatic soldering. Made from solid wire, acid or rosin core. ALL SIZES, SHAPES and ALLOYS . . . rings, washers, pellets, springs, discs and other shapes. ***Write for bulletin.***

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For more information circle **60** on inquiry card.

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JERGUSON VALVES

For Instrument Piping and General Use

YOU can make tremendous time and cost savings with this complete new line of Jerguson Valves for Instrument Piping and General Use.

Threaded connections are reduced from 10 to 3, for these valves combine unions, nipples, reducers, elbows, tees, valve, and drain valve in one space saving unit. One valve replaces the multiple set-up of valves and connections formerly used.

Nine different styles . . . with or without union outlet, as well as offset and jacketed valves.

Features available include safety shut-off; double-seating stem for repacking under pressure; regular or quick-closing stem and lever; regrindable and renewable seats; pressure bleeder valve and test gage connection; outside screw and yoke when desired; throttling stem when desired.

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100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **61** on inquiry card.

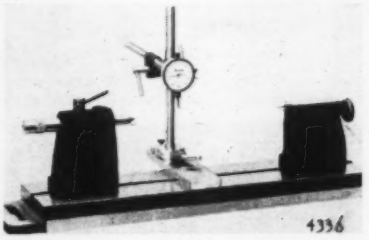
NEW INSTRUMENTS

to 4250 rpm) which automatically drills to any desired depth. Drill feed rate is adjustable.—*Dep't 18, Hillyer Instrument Co., Inc., New York 13, N. Y.*

For more information circle **292** on inquiry card.

Center Checking Set

New Geneva Bench Center Checking Set features upright that tips backward to permit loading, straightening, and adjusting work; maintains original zero setting when returned



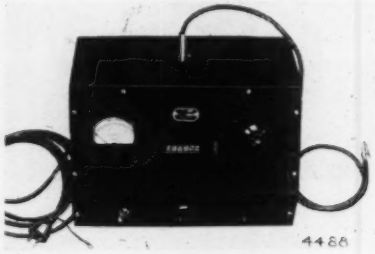
and locked.—*Chicago Dial Indicator Co., Dept. AC, 180 N. Wacker Drive, Chicago, Ill.*

For more information circle **293** on inquiry card.

MECHANICAL TESTING and INSPECTION

Pinhole Detector

New "Model K-1," for rapid pinhole inspection of electrical non-conducting film or sheet, comprises an adjustable d-c. power supply continuously variable from 0 to 7,500 v.; ground return (signal ground) has an indicating cir-

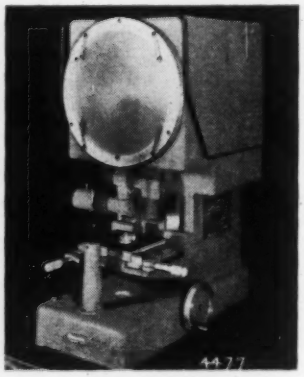


cuit to count number of spark discharges that have occured from inspection electrode and display this record on six-digit counter. New instrument is not intended to be used for dielectric strength tests, but to provide a method where 100 percent inspection for pinholes is required and such tests made on a continuous basis. Provision has also been made for connection to a signal light or bell.—*Tinker & Rasor, 203 Del Mar Place, San Gabriel, Calif.*

For more information circle **294** on inquiry card.

Optical Projector

New "Model 10," said to be "the most versatile projector ever offered," features newly-developed "Syntar" lens systems which produce crisp images having exact magnification at all parts of projection screen. Magnification of 10 to 100 can be obtained by vertical or horizontal projection systems and, in either case, contour

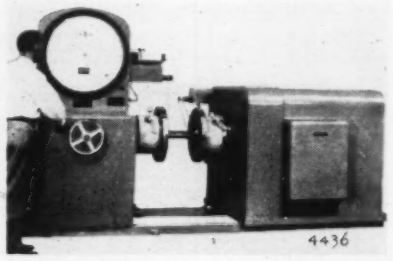


projection, front surface projection, or both are possible by the flick of a switch.—*Stocker and Yale, Inc., 77 Green St., Marblehead, Mass.*

For more information circle **295** on inquiry card.

Double Torsion Tester

New 200,000 lb.-in. torsion testing machine loads and indicates torque in both directions of rotation, obviates

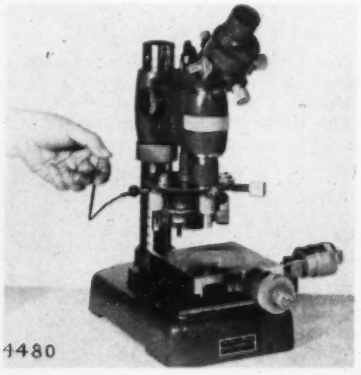


need of taking down a specimen and readjusting grips in order to get full range of twist and pressure. "Electronic Selectorange Indicating System" is coupled directly to double weighing system.—*Tinius Olsen Testing Machine Co., 1023 Easton Road, Willow Grove, Penna.*

For more information circle **296** on inquiry card.

Hardness Tester and Measuring Microscope

New combined micro-hardness tester and measuring microscope comprises Leitz Micro Hardness Tester



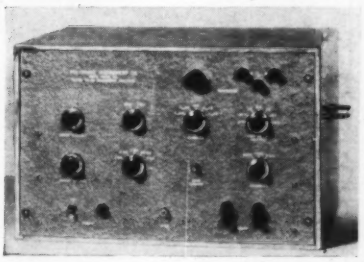
with Vickers Diamond and graduated ocular; special Scherr Micrometer Cross Slide Stage with 1-in. micrometer drums graduated directly in 0.0001 in.—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*

For more information circle **297** on inquiry card.

ELECTRICAL TESTING

Transistor Tester

New "Model TA-3A Transistor Analyzer" tests *n*, *p*, *npn*, or *pnp* units; displays on a 'scope R_{12}, R_{22}, and H_{12} families of curves in grounded base

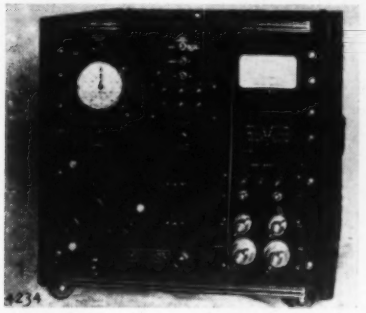


connections, and R_{22} family in grounded emitter connection. Collector current power supply has a peak rating of 100 ma. at 100 v., enabling instrument to be used for testing power transistors.—*Polyphase Instrument Co., Bryn Mawr, Pa.*

For more information circle **298** on inquiry card.

Recloser Tester

New "Model 2040/ACTS," for checking and calibrating reclosers, sectionalizers, overload relays, fuses



and CSP transformer breakers, automatically tests for minimum trip current, sequence operation and co-ordination; is available in models with inputs of 220 or 440 v.ac.—*Multi-Amp Corp., 10 Third St., Newark 7, N. J.*

For more information circle **299** on inquiry card.

H-f. Cable Tester

New "MEKO" self-contained cable measuring set serves for rapid fault location on heavy-current cables by employing high-frequency method

Time the flow of
Gas . . . Liquids . . . Solids
in Split-Second Intervals
with the

POST INTERVAL TIMER

The Post electronic "Interval Timer" permits fractional second timing of any industrial operation. One, or more, different functions can be controlled by various models.

60 Cycle, line-current, is converted to 120 impulses per second. Desired "action-intervals" can be set in increments as fine as 1/120th of a second, and the timer will automatically time the operation. Controls are easily set . . . stay in position.

Filling operations, conveyor feeding, etc. are ideally solved by this latest Post development. *Write for details.*

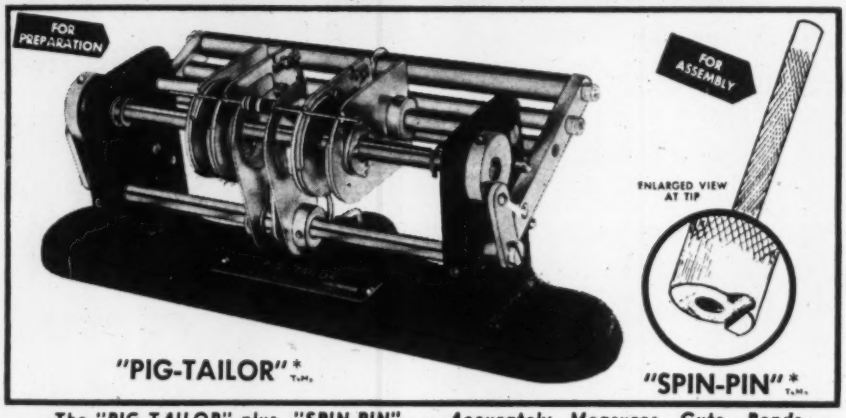
POST

Electronic Products Division
Dept. 551
MACHINERY CO.
Beverly, Mass.

For more information circle **62** on inquiry card.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

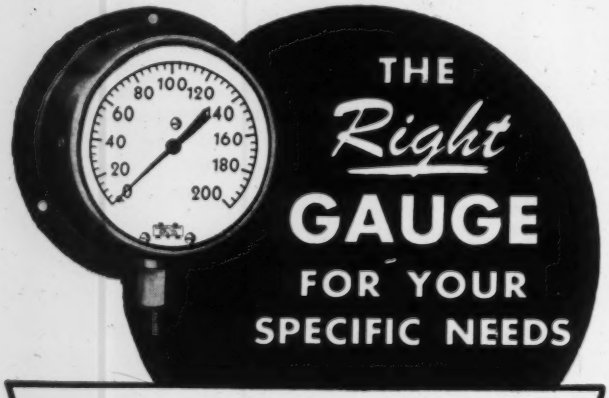
1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept IA5-P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

For more information circle **63** on inquiry card.



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• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

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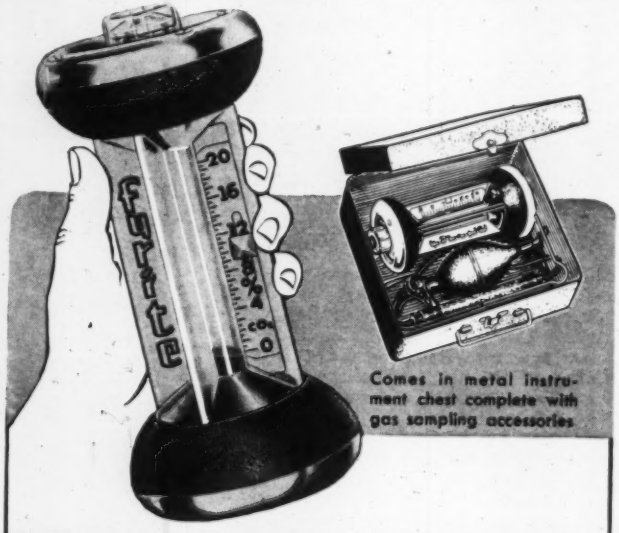
For more information circle **64** on inquiry card.



ACCURATE CO_2 Analysis in 40 Seconds!

Other outstanding features of the FYRITE CO_2 Indicator are its durable, fool-proof construction and unmatched convenience of operation. It requires no setting-up, has no valves or leveling bottle to manipulate.

The FYRITE measures CO_2 directly by the fundamental method of chemical absorption. Consequently, the reading is independent of voltage, humidity, temperature, or atmospheric pressure conditions.

Comes complete with chemical charge good for at least 300 readings. Replacing chemical merely requires removing four screws that hold top assembly in place.

Write for Bulletin 805

BACHARACH Industrial Instrument Company
7301 Penn Avenue • Pittsburgh 8, Pa.

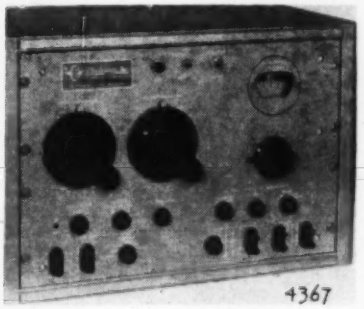
For more information circle **65** on inquiry card.

which makes it possible to detect faults even on a cable being composed of different portions.—*Hartmann & Braun AG, Frankfurt am Main West 13, Germany.*

For more information circle **300** on inquiry card.

Frequency Generator

New "Model 200K Swept Frequency Generator," used in conjunction with maker's large screen 'scope, provides



instantaneous and continuous visual display of frequency response of a device under test; enables designer to instantly determine effects of changes in circuit parameters upon frequency characteristics; covers range from 20 cps. to 200 kc. or any increment of this range.—*Electromec, Inc., 3200 N. San Fernando Blvd., Burbank, Calif.*

For more information circle **301** on inquiry card.

Standard Burden Sets

New standard burdens for testing and calibrating instrument transformers possess freedom from stray fields and harmonics. "Type BSC-5" provides in one unit all three ASA standard burdens for current transformers for metering service, i.e., B-0.1, B-0.2, and B-0.5. For potential transformers (120-v. secondaries), two sets: Three of these burdens, W, X, and Y, are combined in "Type BSP-6"; standard burden Z is supplied in "Type BSP-7," two of which can be used in parallel to obtain ASA burden ZZ. Accuracy of adjustment for resistance and inductance within 0.5 percent.—*Electrical Facilities Inc., 4250 Holden St., Oakland 8, Calif.*

For more information circle **302** on inquiry card.

Comparison Bridge

New "Signa-Glow Model P-10," for rapid comparison tests, features unique "Dual-Null" indicator incorporated into a Wheatstone bridge circuit. Resistance or impedance range 100 ohms to 5 megohms. Two sets of jacks: for "standard" and for "unknown." Operation: "Dual-Null" shows direction of unbalance; pointer-knob, which is turned to reach null, indicates percentage of deviation from Standard.—*Industrial Development Laboratories, Inc., 17 Pollock Ave., Jersey City, N. J.*

For more information circle **303** on inquiry card.

Comparison Bridge

Newly redesigned "Model E-2" can be operated by means of an optional foot switch, as well as by conventional push button. Improved stability, accuracy and sensitivity (to 0.1 percent) enable resistors, capacitors and inductors to be compared over a range of 1 ohm to 5 megohms at 60 cps.—*Southwestern Industrial Electronics Co., 2831 Post Oak Road, Houston, Texas.*

For more information circle **304** on inquiry card.

Calibration Standard

New "Model M100A-20" for laboratory and production calibration of d.c. indicating instruments, provides voltage and current calibration ranges from 0 to 1000 v. at 200 ma. maximum and from 0 to 100 ma. at 1000 v. maximum. Long-time stability 0.01 percent; accuracy 0.05 percent.—*Kalbfell Labs, Inc., P. O. Box 1578, San Diego 10, Calif.*

For more information circle **305** on inquiry card.

Power Monitor

New "Model 164" bi-directional power monitor simplifies measurement of incident or reflected power and speeds

matching loads to line. Twist of wrist selects incident or reflected power, or any power range, without requiring removal of power, at all frequencies from 25 to 1,000 Mc.—*Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif.*

For more information circle **306** on inquiry card.

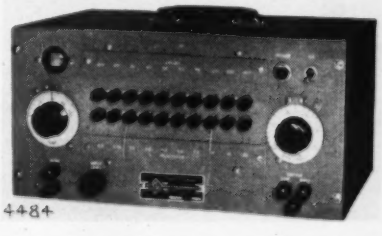
Signal Tracer

New "Model 147 Deluxe Milti-signal Tracer" is said to feature unsurpassed facilities for RF, IF and audio signal tracing and trouble-shooting in AM, FM and TV sets.—*Electronic Instrument Co., 84 Withers Street, Brooklyn 11, N. Y.*

For more information circle **307** on inquiry card.

Push-button Oscillator

New "Model TO-100A Push Button Test Oscillator" permits any of 19 different preselected frequencies between 20 cps. and 20 kc. to be selected by push button controls. A de-



Viking miniature connectors

DESIGNED FOR LONG, RELIABLE SERVICE LIFE

VIKING circular types. Positive polarization and shielding. Simple locking device mates units against vibration. One to four contacts on small units—5 to 9 on large units.

VIKING printed circuit receptacle. Increases your circuits—unit shown has 20 contacts, and is interchangeable with 18-contact types. Extremely strong contacts, pierced or unpierced.

Hermetic sealing is available on the circular and rectangular series. Write for literature on these or the complete line of VIKING connectors.

VIKING ELECTRIC

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For more information circle **66** on inquiry card.

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MAGNETIC
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SPECIFY JAN'S MU-METAL SHIELDS

- DE-IONIZED and TOTALLY ANNEALED under HYDROGEN
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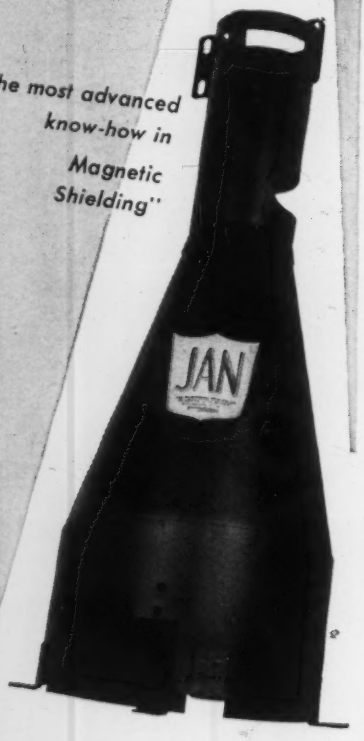
- FUNCTIONAL DESIGN

"The most advanced know-how in Magnetic Shielding"



AVAILABLE FROM STOCK — Over 150 combinations of engineered Bezel and Shield assemblies including heavy rubber cushions and calibrated filters FOR ALL POPULAR C. R. T. AND PHOTOMULTIPLIER TUBES.

QUICK DELIVERY OF SPECIAL PROTOTYPES.

JAN HARDWARE MANUFACTURING CO., INC.
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For more information circle **67** on inquiry card.

viation dial permits calibrated deviation from center frequencies up to plus or minus 10 percent. Output frequencies include those recommended by FCC for distortion measurements on broadcast transmitters.—*Teletronics Lab., Inc., 54 Kinkel St., Westbury, L. I., N. Y.*

For more information circle **308** on inquiry card.

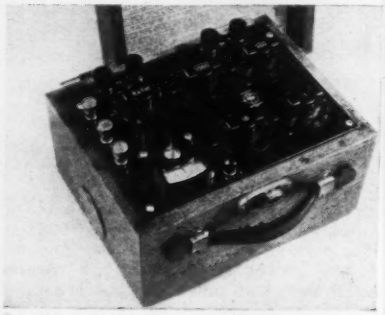
Radio Tester

New Test Meter "Type 5819-A," for testing of mobile radio equipment, functions as a micro-ampere-galvanometer, as a micro- or milliammeter, and as a d-c voltmeter with ranges up to 1,000 volts d.c.—*Allen B. Du Mont Labs., Inc., 1500 Main Ave., Clifton, N. J.*

For more information circle **309** on inquiry card.

Gasketed Bridges

New "Type RN" portable Wheatstone bridges are completely gasketed to prevent infiltration of metal par-

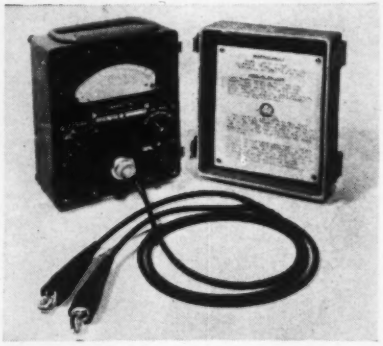


ticles; available with or without Murray and Varley loops. Ratios guaranteed to 0.05 percent and dial resistors to 0.1 percent.—*Industrial Instruments, Inc., Cedar Grove, N. J.*

For more information circle **310** on inquiry card.

Low-resistance Ohmmeter

New "Model LRO," featuring extremely low test current, is especially suitable for measuring resistance of

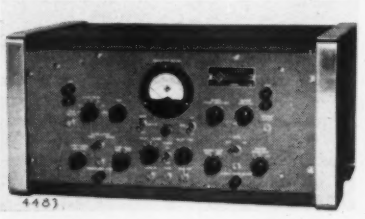


relay contacts, fuses, bonding and ground wires, etc. Full-scale ranges 0.1, 1 and 10 ohms; current through test piece never exceeds 110 ma.; accuracy 1 percent.—*Industrial Instruments, Inc., Cedar Grove, N. J.*

For more information circle **311** on inquiry card.

Pulse Generator and Calibrator

New "Model PC-100A" produces two rectangular pulses having independently controlled amplitudes and polar-



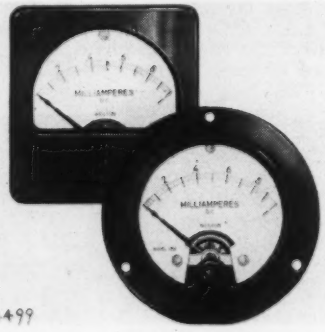
ities; polarities positive or negative; amplitudes 0-75 v. open circuit from a 220-ohm source; repetition frequencies adjustable at 50-5,000 pps.; paired-pulse interval adjustable at 5-5,000 usec. Time markers provided at 1, 10, and 100 usec. Square-wave calibrator output 60 cps., 0.1 to 100 v. —*Teletronics Lab., Inc., 54 Kinkel St., Westbury, L. I., N. Y.*

For more information circle **312** on inquiry card.

ELECTRICAL INSTRUMENTS

Core-magnet Instruments

New "1301 Line" of core-magnet self-shielded panel instruments in 3½-in. size includes d-c. or a-c rectifier type instruments in both round and



rectangular shapes. With maker's "Cormag" mechanism, instruments can be mounted close together and can also be mounted on magnetic or nonmagnetic panels interchangeably without need for special adjustment. Basic accuracy is within 2 percent (3 percent for a-c. rectifier types). —*Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*

For more information circle **313** on inquiry card.

Panel Instruments

New line of "Reference Standard" panel instruments is complete: a-c. and d-c. ammeters, voltmeters, wattmeters, fluxmeters, thermocouple instruments, differential galvanometers and many specialized types. Accuracies: (1) 0.25 percent, highest offered

"BANTAM"

500 SERIES

Miniature Throttling

Diaphragm Control Valves

Because of the growing need for compactly designed, lightweight valves with the same ruggedness of construction and high quality found in standard dimensioned control valves, this new line of "Bantams" is offered.

The valve shown has ¼" N.P.T. connections, and for service up to 1000 psi at 350°F. will provide throttling control with low hysteresis and instantaneous response over a 3 to 15 psi instrument air range. It has five interchangeable sizes of linear, equal percentage, or quick opening trim. CV = 0.63 and below.

Other 500 series valves are available in sizes from 1" to ¼" screwed, flanged, and weld ends, for service up to 1500 psi in A.S.A. Ratings. All materials and construction consistent with usual control valve specifications including stainless steel body and trim with Teflon packing and gaskets as standard. Direct or reverse action, top mounted positioners and handjacks are available.

For a full description of the Bantam 500 series, drop us a line. We will be glad to put you in touch with our representative in your area.

George W. DAHL Company

BRISTOL, RHODE ISLAND

For more information circle **68** on inquiry card.

EPLAB

PYRHELIOMETER

For the Measurement of SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.

Newport, Rhode Island U.S.A.

For more information circle **69** on inquiry card.

ANNOUNCING!

NEW SCAM DU-ALL annunciator with FLASHING SEQUENCE

SCAM

Model SC-10 Pat. Pending

Model SC-10 provides for the first time an extremely compact annunciator design which includes dual lamps, hermetically sealed plug-in relays and a flashing, back lighted name plate indication which is most commonly used in modern control panels.

Alarm Sequence:

Normal: lights off, horn off
Abnormal: lights flashing, horn on
Reset: lights bright, horn off
Normal again: lights off, horn off

Features of the SC-10 MODEL

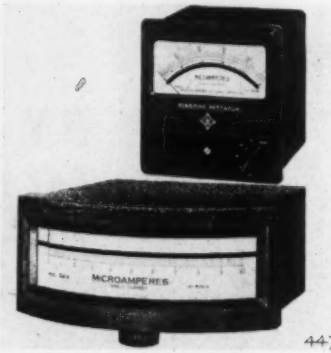
1. Interchangeable with standard Scam systems.
2. Operates with normally open field signals.
3. Optional Lock-in of momentary alarms.
4. De-energized circuit (no-drain).
5. Photograph illustration above with 20 alarm stations requires panel area of only 7⅝" high x 17⅜" wide.
6. Two lamps for each indication.
7. Economical

THE SCAM INSTRUMENT CORP.
Chicago 18, Illinois

Sales Representatives Chicago, New York Philadelphia • Boston • Buffalo • Pittsburgh Canada • Cleveland • Atlanta • Los Angeles San Francisco • Seattle • Houston • St. Louis Kansas City • Cincinnati

For more information circle **70** on inquiry card.

NEW INSTRUMENTS



4470

in a panel instrument by any maker, and (2) 0.5 percent—both depending on sensitivities desired.—*Sensitive Research Instrument Corp., Mt. Vernon, N. Y.*

For more information circle **314** on inquiry card.

Laboratory CRO

New "Type 340" is a low-cost laboratory-type cathode-ray oscilloscope featuring identical X- and Y-amplifiers, both with frequency response extending from dc. to 30 percent down at 100 kc. It can be used for accurate phase comparisons with less than 1 deg. phase shift between X- and Y-amplifiers at frequencies below 100kc. Deflection sensitivity of Y amplifier 25 mv./in. peak-to-peak; of X, 32 mv./in. (due to difference in deflection-plate sensitivities of CRT: amplifiers identical in all other respects).—*Instrument Div., Allen B. DuMont Labs., Clifton, N. J.*

For more information circle **315** on inquiry card.

VTVM

4471

New "Model 207A" utilizes a unique logarithmic movement which provides user with a logarithmic voltage scale and a linear db scale. Accuracy is always in percent of reading, not of full-scale. Effective scale length 7-½ in. Ranges: Volts full scale 0.001 to 100 by factors of 10; (calibrated RMS value of sine-wave) 0.003 to 300 by factors of 10; db −60 to +50 in steps of 10 db; frequency 20 cps to 2 Mc.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Station A Richmond, Calif.*

For more information circle **316** on inquiry card.

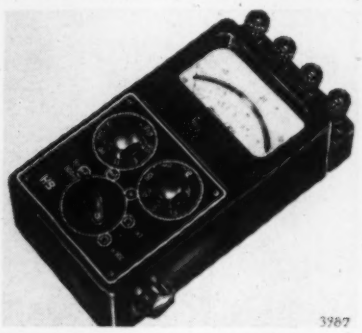
Signal Generator

New improved design of maker's "Model 705 Wobbulator" is said to incorporate "several features never found before in equipment of this type." It combines a swept-frequency signal generator with a built-in 'scope. Frequency range 2.0 to 1000 Mc.; continuous single-knob tuning with calibrated dial.—*Canoga Corp., 5955 Sepulveda Blvd., Van Nuys, Calif.*

For more information circle **317** on inquiry card.

Forty-range Instrument

New "Multavi HO" high resistance universal measuring instrument covers 40 measuring ranges: 30 ua. to



3987

1500 ma.dc.; 150 ua. to 1500 ma.ac.; 300 mv. to 600 v.dc. at 33,333 ohms/v.; 1.5 to 600 v.ac. at 10,000 ohms/v.; 10 kilohms; 1 megohm.—*Hartmann & Braun AG, Frankfurt am Main West 13, Germany.*

For more information circle **318** on inquiry card.

Two-channel CRO

New "Model K-26" 2-channel oscilloscope employs two completely separate and independent channels with both signals displayed on the 5-inch screen of a single dual-beam cathode-ray tube. Frequency response of both vertical and horizontal amplifiers is flat from dc to 100 kc. (10 percent) —*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **319** on inquiry card.

The Office National d'Etudes et de Recherches Aéronautiques
55 bd Malesherbes
Paris, France

holder of following U.S. patents:

No. 2,654,287, Oct. 6, 1953 —Spectrophotometer

No. 2,679,010, May 18, 1954 —Infrared spectrophotometer

No. 2,684,067 July 20, 1954 —Soundproof shield

No. 2,692,178, Oct. 9, 1954 —Method and material for graphic registering or direct recording

No. 2,693,908, Nov. 9, 1954 —Apparatus for the analysis of a record and the indication of the correlation factor

No. 2,696,731, Dec. 14, 1954 —Measurement of the proportion of a paramagnetic gas in a gaseous mixture

should like to deal with manufacturers in the United States for licensing.

For more information circle **71** on inquiry card.

Frequency Standard

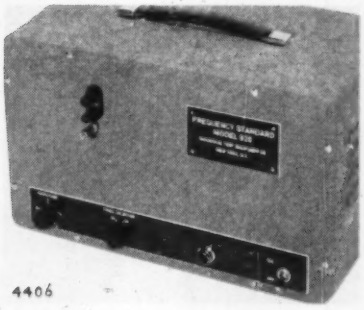
New "Model FS-1" signal generator serves as a secondary frequency standard with a short-time accuracy of one

part per million; long-time accuracy of stabilized characteristic 100-kc. standard crystal of 20 parts per million over normal room temperature ambient range. It generates 12 standard frequencies between 20 cps. and 100 kc.; 11 sine wave frequencies at approx. 1-volt level; a constant 100-kc. signal can be used for reference to a primary standard or to WWV.—*D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif.*

For more information circle **320** on inquiry card.

Frequency Standard

New "Model 620" can deliver up to 5 volts at a precise frequency of 60 or 120 cps. (factory set to within 0.01

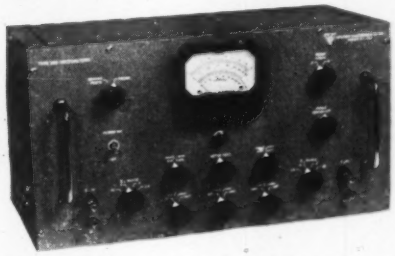


percent); other frequencies on request. Temperature variations from −40 C. to 85 C. or line voltage variations from 105 to 125 will affect frequency of oscillation by less than 0.01 percent. Output distortion is less than 1 percent.—*Industrial Test Equipment Co. 55 E. 11th St., New York 3, N. Y.*

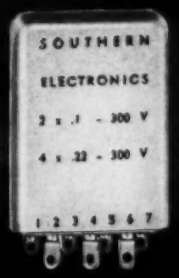
For more information circle **321** on inquiry card.

Vector-relation Indicator

New "Type 202 Vectorlyzer" is said to make possible "for the first time a number of measurements which were



formerly impossible or at least very difficult to accomplish by other means." Example, phase angles as small as a fraction of one degree with maximum error less than 2.5 percent. Instru-

Condense  and Save!

plastic condenser block capacitors save you Space, Labor, Money!

Multiple capacitors in **one** block! Now you can install one capacitor case and use 125% less space as before —at a saving in labor costs of up to 300%.

Available with polystyrene or MYLAR* dielectric to tolerances as close as 1%.

NOW!

Precision Decade Capacitors

with attached rotary switch or completely boxed.

CAPACITANCE . . . FROM .001 TO 10 M F D

CHECK THESE OUTSTANDING FEATURES:

- STANDARD VOLTAGE RATING . . . 200 V. D. C.
- VERY HIGH INSULATION RESISTANCE
- LOW DISSIPATION FACTOR
- LOW DIELECTRIC ABSORPTION
- SMALL SIZES

Available with polystyrene or MYLAR* dielectric to tolerances as low as 1%.

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Join America's leading electronic equipment manufacturers in specifying Southern Electronics' precision polystyrene capacitors for your most exacting requirements. Write for complete catalog today!

SOUTHERN ELECTRONICS *Corporation*

239 West Orange Grove Ave., Burbank, Calif.

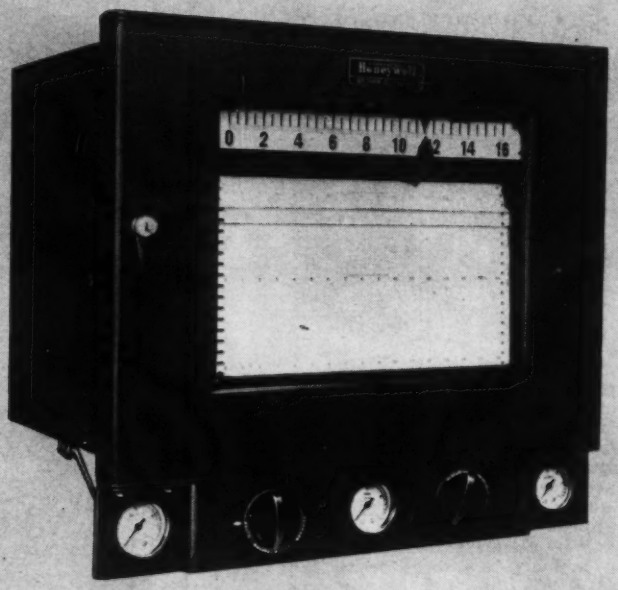
For more information circle **72** on inquiry card.

STRIP CHART

ElectroniK

Controllers

. . . preferred for applications that require highly detailed records on 11-inch-wide charts covering weeks of operation. Control point can be set to desired value with high precision. Automatic standardization on all potentiometer models. Supplied with or without integral by-pass.

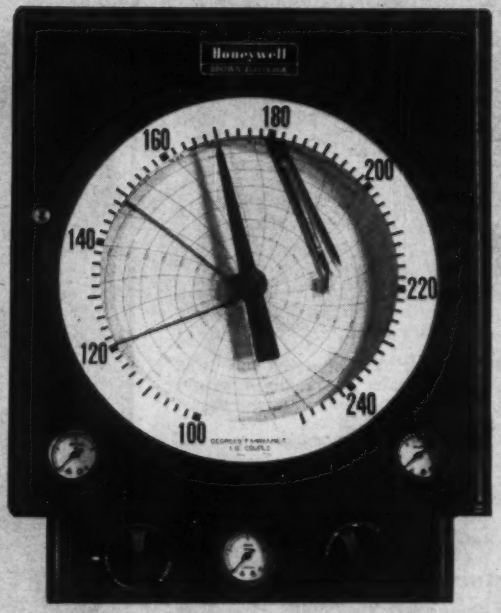


CIRCULAR CHART

ElectroniK

Controllers

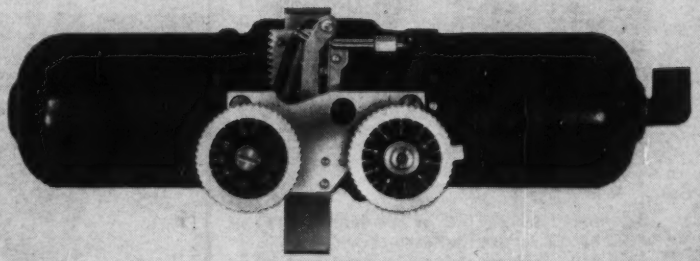
. . . provide high accuracy and high readability of the indicated value. 12-inch circular charts are convenient size for filing. Push-button standardization on potentiometer models. Available with or without integral by-pass panel.



Air-O-Line

CONTROL UNIT

. . . capable of handling practically any control problem, with proportional action and automatic reset. Proportional band width is adjustable up to 150%. Liquid reset system needs no volume or capacity tanks . . . provides linear reset rate. Reset action continues as long as the pen is off the set point. Rate action may be added when required. The complete unit is sealed, interchangeable, readily adjustable. Simple, sturdy design assures reliable operation.



For more information circle **73** on inquiry card.

Design for *extra* precision and flexibility— use *ElectroniK* instruments with ***Air-O-Line*** control

WHENEVER a process calls for air-actuated control, here's an unbeatable combination that fills the bill as no other can . . . *ElectroniK* instruments with *Air-O-Line* control. In these controllers are joined the speed, precision and dependability of *ElectroniK* measurement, plus the flexibility and sensitivity of the *Air-O-Line* control system.

Versatile *ElectroniK* instruments are applicable to an almost unlimited variety of variables—temperature, flow, pH, chemical composition, liquid level, weight of solids. With their *Air-O-Line* system, they provide the peak in performance as individual controllers or in cascade circuits.

In every detail, these controllers are engineered with the instrument man in mind. Air gages and adjustment dials are spotted for maximum convenience. Every component is precision-made, with plenty of reserve strength built in to assure long, trouble-free service . . . and assembled into a compact unit in which all parts are available for easy inspection and maintenance.

Compare the features of these controllers . . . and you'll see why quality-conscious and economy-conscious designers choose them for so many vital process responsibilities. For a discussion of how you can use them in your own applications, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Catalog 1531, "*ElectroniK* Controllers."**

MINNEAPOLIS **Honeywell**

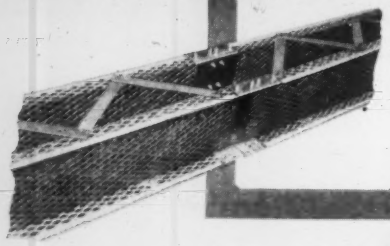
BROWN INSTRUMENTS

First in Controls

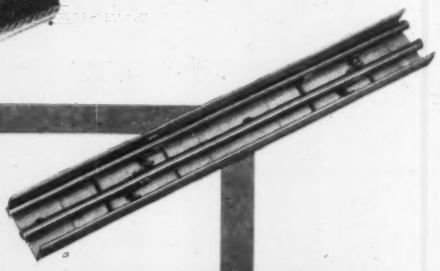
For more information circle **73** on inquiry card.

INSTROF

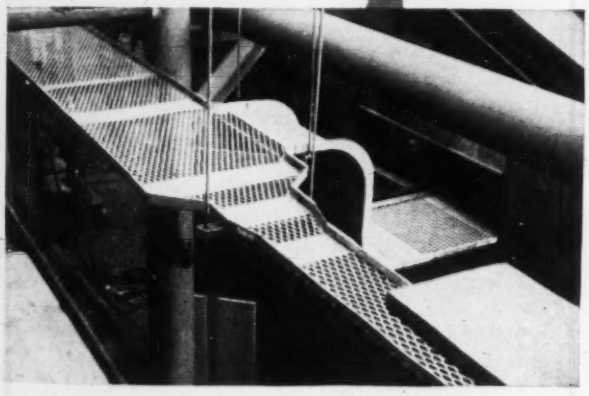
for the support of instrument tubing



BOX GIRDER—for long unsupported span lengths.



TUBE RACE—for branch run.



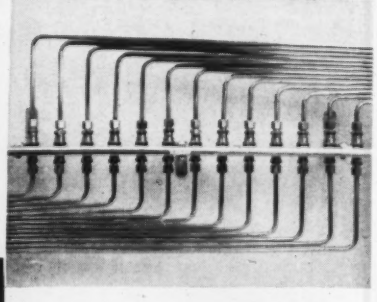
The Instrof System installed in a large South-West Coast Chemical Plant. All fittings are stock items which were rapidly assembled on the job. System is ready for placement of tubing.

Instrof is a system of prefabricated metal trough specifically designed to give continuous support and protection to instrument tubing. It is the most versatile system of its kind on the market today, and can be readily assembled at the job site in an extremely short time. Once installed, it requires no maintenance.

Instrof is available in widths of 3", 6", 9", 12", 18", and 24" with a complete range of fittings for all widths. These fittings enable the system to follow walls, change direction and elevation, and to change from one width to another—in short, to conform to any plant layout.

For further information on how the Instrof System can help solve your tubing problems, write today for the new Instrof Catalog. Ask for Bulletin I-5.

The Instrof Bulkhead Bar is a light section of channel with ¼" brass couplings mounted on 1½" center. It can be used wherever straight or angle tube terminal connections are required, such as junction boxes, panel boards, etc. It is especially adaptable to mounting on Instrof sections. The standard bar contains 40 ¼" brass couplings and is five feet long. Other sizes can be manufactured to customer's specifications.



INSTROF INCORPORATED

4923 PENTRIDGE ST. PHILADELPHIA 43, PA.

For more information circle **74** on inquiry card.

ment measures (1) vector sum or vector difference of two voltages; (2) imaginary and real components of an unknown voltage in terms of a reference voltage; (3) phase angle between two alternating voltages; (4) voltage across two points both above a.c. ground potential; (5) magnitude and phase angle of an unknown impedance. Frequency 8 cps. to 2 Mc. Probe frequency 100 kc. to 500 Mc. Voltage ranges 0.04/0.4/4/40; phase angle ranges 0-180, 180-360 deg. (better sensitivity through panel adjustment).—*Advance Electronics Co., Inc., 451 Highland Ave., Passaic N. J.*

For more information circle **322** on inquiry card.

Digital Voltmeter

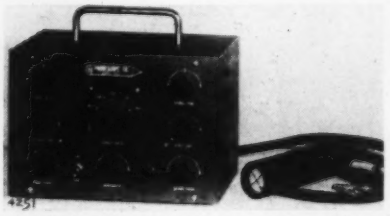
New "Model 419" is a self-balancing digital potentiometer for measuring direct voltages from 0.001 to 999.9; makes an average of 100 zero-to-full-

scale readings per minute, with automatic indication of polarity and decimal position, has Weston Standard Cell for calibration. Input resistance is order of 1000 megohms on low range (up to 9.999 volts) and 11 megohms on high range (100.0 to 999.9 volts).—*Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.*

For more information circle **323** on inquiry card.

CRO and Probe

New "Model PO-1," smallest complete oscilloscope on market, measures 6 x 9 x 5 in. and weighs 7½ lbs.; its



probe has a 1-in. Mu-Metal shielded CRT said to display wave-form "even sharper and clearer than on larger oscilloscopes."—*Probescope Co., 44-05 30th Ave., Long Island City, N. Y.*

For more information circle **324** on inquiry card.

Reed Frequency Meters

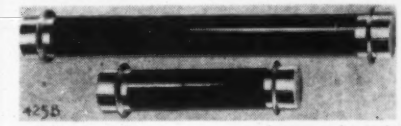
New "Standco" line of 3½-inch flush-panel-mounting vibrating-reed frequency meters are available with 5, 7, 9, 11, 21, 36, or 41 reeds for normal frequencies of 25, 50, 60 and 400 cps.—*Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.*

For more information circle **325** on inquiry card.

ELEC.-INSTRUMENT ACCESSORIES

Meter Multipliers

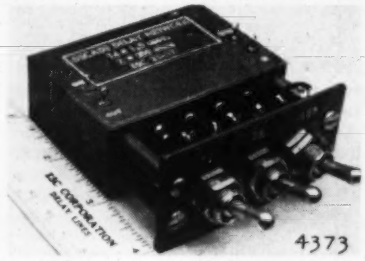
New "Types MFA and MFB," for use with 1-ma. instruments, as well as other measuring equipment, will withstand indefinite exposure to high humidity, salt spray, or immersion in salt water; fully meet JAN-R-29; standard tolerance 0.5 percent; special tolerances of 1, 0.25 and 0.1 percent available.—*Resistance Products Co., 914 S. 13th St., Harrisburg, Penna.*



For more information circle **326** on inquiry card.

Decade Delay Network

New "Model 21-19" decade pulse forming network provides pulse formations from 0.25 usec. to 2.0 usec. in width by means of three miniature toggle switches. Circuit is arranged to provide a residual pulse width of 0.25 usec. at all times.—*ESC Corp., 534 Bergen Blvd, Palisades Park, N. J.*



For more information circle **327** on inquiry card.

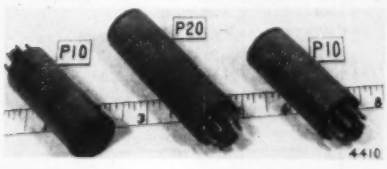
Rectifier Stack

New "Mastodon Rectifier Stack" is 12 ft. long; comprises 48 selenium stacks mounted in an angle iron frame, protected with fungus-resistant paint and corrosion-resistant varnish.—*The Electronic Rectifier Co., Rochester, N. Y.*

For more information circle **328** on inquiry card.

Plug-in Delay Lines

New "Pluglines" are available in 186 types and in two versions: Capped (C) has octal plug at one end and solid cap at other. Socket (S) has octal plug at one end and octal socket at other: input at one of plug pins and output available at both plug and socket; delays of several lines can be added by plugging them together. Four different series are of-



Circle **75** on inquiry card. ⟶

THERE'S MORE FOR YOUR MONEY··IN PANALARM "50" ANNUNCIATOR SYSTEMS

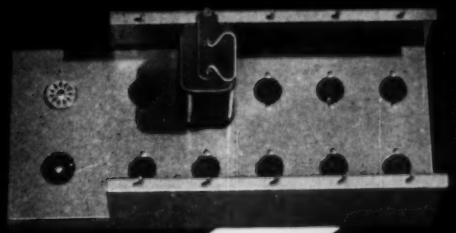
No annunciator system ever offered as much in value as PANALARM "50".

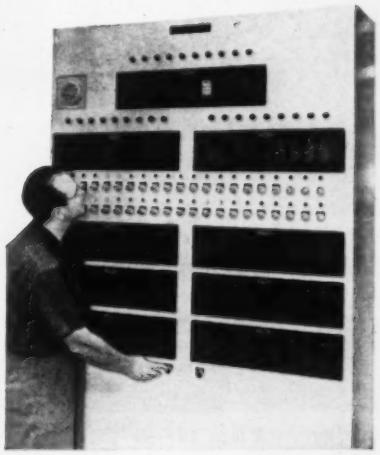
Examine for yourself every piece and component . . . consider the savings you realize through standardization and complete flexibility that only PANALARM "50" provides.

Then, evaluate *dependability*. Beyond all else, PANALARM "50" represents the greatest value in audio-visual alarm systems by its record of *dependable service* alone.

STANDARD CHASSIS

is interchangeable without re-wiring for all types of annunciator service: standard audio-visual; ringback; bullseyes or nameplates; trouble or running signals; lock-outs; or low drain operation.





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In hundreds of plants—serving for many years—Panalarm Annunciators have demonstrated outstanding performance. They have won confidence for the very critical part they play in plant operation and safety.

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. . . *heart of the system* . . . incorporate finest telephone-type relays and special contact arrangements . . . assure sequential operation. Hermetically sealed suitable for Class I, Div. 2 locations.

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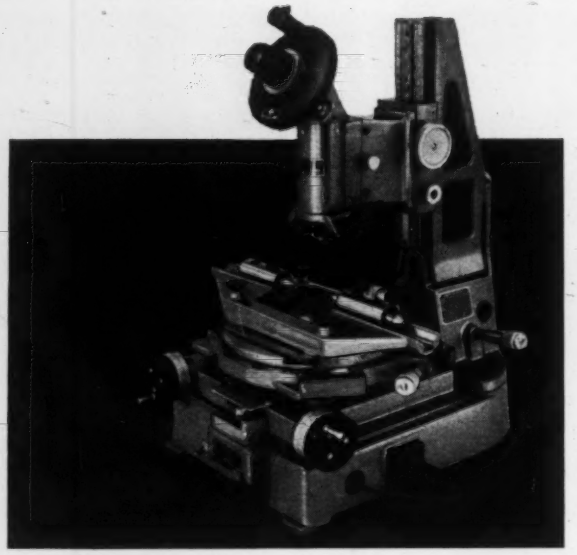

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Direct Reading to	.0001"
Angular Range	360°
Reading to	1 minute
Magnification	30X
Protractor Range	360°
Reading to	1 minute

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The Gaertner Scientific Corporation

1211 Wrightwood Avenue, Chicago 14, Ill.

[redacted]

WRITE FOR BULLETIN NO. 147-50

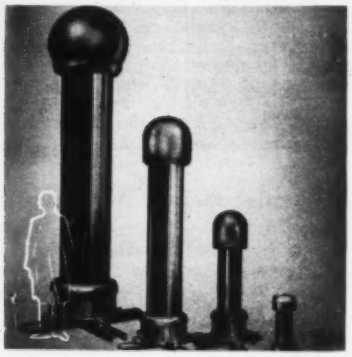
For more information circle **76** on inquiry card.

fered, differing in complexity of construction and hence in ratio of delay time to rise time; in each series a wide variety of combinations of delay time and characteristic impedance.—*Jacobs Instrument Co., Bethesda* 14, *Md.*

For more information circle **329** on inquiry card.

Compressed-gas Capacitor

New "CLP 800" lossfree compressed gas capacitor, about 13 ft. high, is used for measuring capacitance and

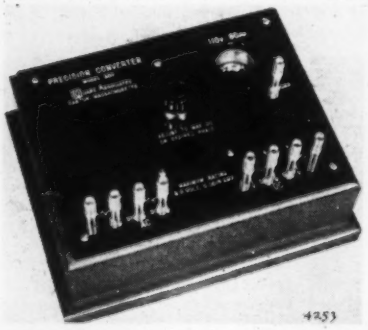


loss angle of high-voltage material, also as high-voltage branch for capacitance potential divider circuits. It is filled with pure nitrogen at about 200 psi.—*Hartmann & Braun AG, Frankfurt am Main West* 13, *Germany.*

For more information circle **330** on inquiry card

Laboratory Converter

New "Model 300" high-precision (0.05 percent) a.c. to d.c. and d.c. to a.c. converter can be used for direct



4253

Analog-to-digital converters
Analytical control equipment
Automatic control valves
Automatic control systems
Automatic feeding devices
Automatic gaging equipment
Automatic handling equipment
Automatic inspection devices
Automatic loaders
Automatic machine controls
Automatic tape controls
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Brakes, clutches and drive mechanisms
Central control systems
Color process controls
Communication systems including closed circuit television, telephone and paging systems
Compressors for automation air
Computers, analog or digital
Computer components
Continuous gas analyzers
Continuous testers
Conveyors
Counters
Data processing and data reduction systems
Data transmission and computing systems
Decade counters
Door operators, automatic
Dust and atmosphere controls
Electric motors
Electronic computers
Electronic control devices
Electronic, electrical and mechanical components for automatic production systems
Gages, air
Governors
Hydraulic cylinders and motors
Indexing machines
Industrial television, closed circuit
Infrared absorption analyzers
Instrumentation and automation panels and cubicles
Instruments for measurement and control
Level controllers
Limit switches
Mass spectrometers
Metering equipment
Monitoring systems
Monorails
Motor controls
Optical gages and inspection devices
Packaged servo controls
Photoelectric control devices
Pneumatic tubes
Positioning equipment
Power supplies
Printed code readers
Radioactivity equipment
Recording equipment
Remote control systems
Scales
Scanning systems
Servo-components
Servomechanisms
Signalling equipment
Speed controls
Strain measuring devices for automatic control
Switches, relays and other electrical components
Teleprinters and facsimile recorders
Two-way radio
Ultraviolet absorption analyzers
Vibration control equipment
Weighing and proportioning equipment
Work positioning mechanisms
X-ray and fluoroscopic devices
X-ray gages

If you manufacture any of the above or similar products turn to advertisement number 100 on page 837.

conversion of unknown a-c. voltages and currents to d.c. for measurement to precision of five-place standard-cell-controlled potentiometers. D.c. can also be changed to a.c. so that linearity of a-c. lab standards can be checked with a battery and a good decade divider. Numerous other uses.—*Quare Associates, P. O. Box 95, Canton, Mass.*

For more information circle **331** on inquiry card.

Voltage Regulator

New "RX400" is all-static, provides precise voltage regulation for 400-cps. generating equipment under all load conditions; meets all performance requirements involving response time and regulation; obviates need for a rotating d-c. exciter.—*Inet Div., Leach Corp., 4441 Santa Fe Ave., Los Angeles 54, Calif.*

For more information circle **332** on inquiry card.

AMPLIFIERS

Magnetic Amplifier

New "Model B-1" 400-cps. self-saturating magnetic amplifier, for use with BuOrd Mark 7, Mark 8 and Mark 14 Mod 2 servomotors, employs half-wave circuits with their inherently rapid response to enable use in systems with required bandwidths of up to 20 cps. Standard units hermetically sealed with gain and compensation fixed for a given system. Units with adjustable gain and compensation can be supplied.—*Feedback Systems, Inc., 1332 N. Henry St., Alexandria, Va.*

For more information circle **333** on inquiry card.

Magnetic Amplifier

New "Relay Amplifier" is a 3-lb. magnetic amplifier providing a constant output throughout a wide range of shock and vibration levels. Designed to eliminate thyratron circuits, with their attendant noise problems, and small sensitive relays, it insures safe operation of components such as stepping switches, solenoids, heavy-duty relays, d.c. motors, etc. Power amplification ratio: under 1 milliamp. 2 volts, to ¾ amp. 28 volts. Input may be a.c. or d.c. Models for intermittent use and for continuous operation.—*The Goldak Co., 1544 Glenoaks Boulevard, Glendale 1, Calif.*

For more information circle **334** on inquiry card.

Direct-coupled Amplifier

New "Model D-1" is so versatile that it can be used for many applications formerly requiring specialized instruments. Maximum useful over-all gain is 80,000; frequency response flat from zero to more than 100 kc. at gain settings up to 10,000.—*Southwestern Industrial Electronics Co., 2831 Post Oak Road, Houston, Texas.*

For more information circle **335** on inquiry card.

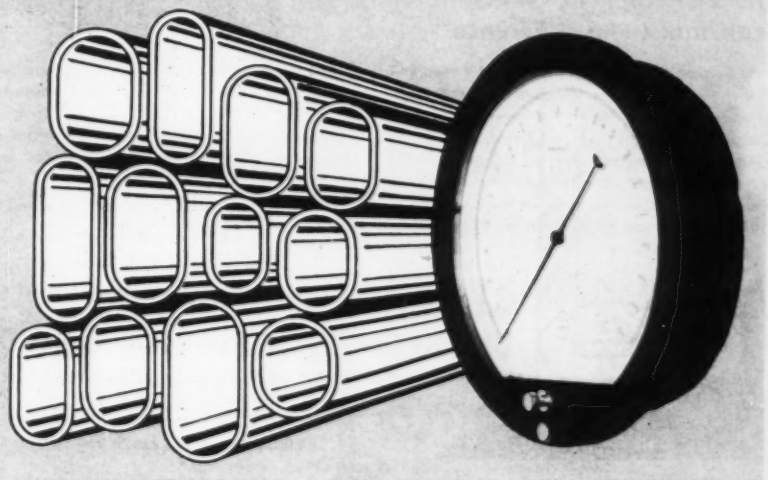
Power Amplifier

New "Model UF-101" features extremely low distortion, achieved by incorporating 80 db of negative feedback. Rated harmonic and intermodulation distortion is less than 0.005 percent at 50 watts output. Frequency response is flat plus or minus 0.5 db from 0.5 cps. to 30 kc. Excellent transient response is maintained at all out-

HEISE GAUGES

Designed for Dependability

Does your high pressure gauge application require a scientifically designed Bourdon Tube?



Where highly accurate results are required design considerations such as the depth — width ratio of the Bourdon Tube section are of paramount importance.

Extreme fiber stress resulting from improper design of the tube may render an apparently good instrument completely undependable.

At the Heise Laboratories, mathematical solutions for determining the size and shape of Bourdon Tubes for specific use are augmented by years of research and tests on various types of tubes to assure correct stress distribution.

Heise Bourdon Tubes are heat treated by scientific methods to guarantee that each tube will be metallurgically sound for its application. The precision heat treatment of thin walled tubing without distortion has been made possible by equipment and technique developed by Heise Laboratories.

Catalog on Request

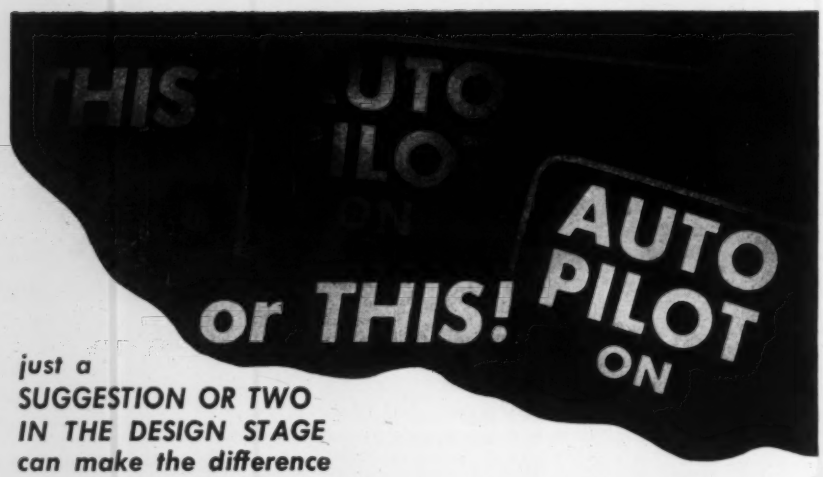
Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"—12"—16"

Prices from $151.60. **DELIVERY WITHIN 30 DAYS.**

HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **77** on inquiry card.



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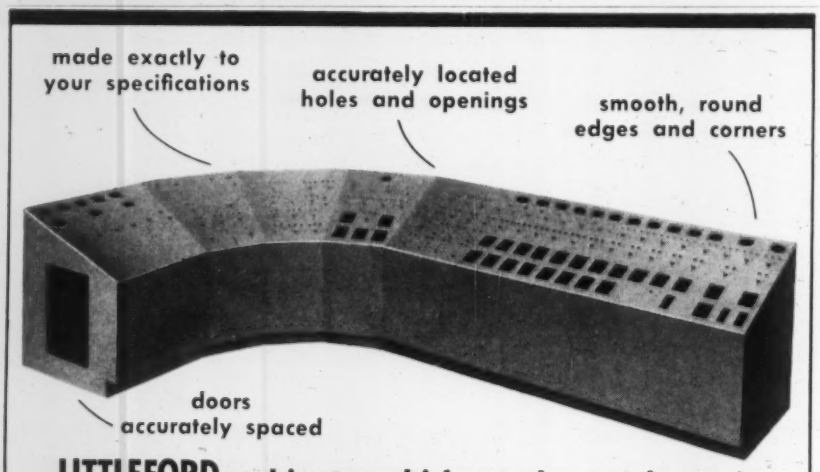
For more information circle **78** on inquiry card.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accurately located holes and openings
smooth, round edges and corners
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For more information circle **79** on inquiry card.

put impedances from 2 to 450 ohms by switching feedback to output transformer secondary winding being used. D.c. on input stage heater maintains noise 110 db below full output.—*Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **336** on inquiry card.

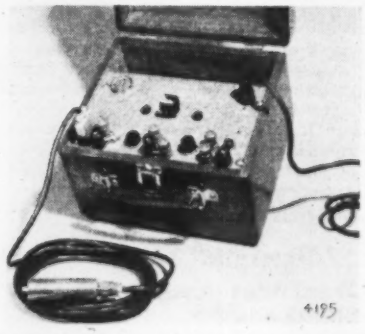
VSWR Amplifier

New "Type 277" is an inexpensive low-noise, high-gain audio amplifier, sensitivity 0.3 microvolts for full-scale deflection on indicator; for use with slotted sections in measuring VSWR over exceptionally wide range of 1.0 to over 100. Special circuitry providing expanded scale makes possible accurate reading of VSWR from 1.0 to 1.3.—*Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.*

For more information circle **337** on inquiry card.

Coupling Amplifier

New modified model of "Glennite F 406" has a current sensitivity over 30 ma./volt (three times that of original), features frequency range from



4 to 50,000 cps. and a separate input so that a padding network can easily be inserted between cathode follower output and amplifier input.—*Gulton Mfg. Corp., Metuchen, N. J.*

For more information circle **338** on inquiry card.

Low-level Preamplifier

New "Type 53E Low-Level Differential Plug-In Preamplifier," for use with maker's "Type 530-Series" 'scopes, feature sensitivity 50 uv./cm. to 10 mv./cm. in eight calibrated steps; continuously variable over same range. Frequency 0.06 cps. to 60 kc. High- and low-frequency controls permit restricting bandwidth, when desirable, to further increase signal-to-noise ratio. Weight 4½ lbs.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*

For more information circle **339** on inquiry card.

Servo Amplifier

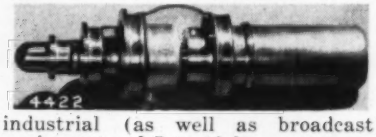
New "Model 32" 8-tube servoamplifier, designed to drive pneumatic or hydraulic servovalves in power servo applications, features excellent dynamic response, variable frequency dither oscillator, 4-kc. oscillator to excite variable reluctance or *E*-type transformer pickoffs, and provision for plug-in compensating networks to alter servo system dynamic response where required.—*Raymond Atchley, Inc., 12012 W. Pico Blvd., Los Angeles 64, Calif.*

For more information circle **340** on inquiry card.

ELECTRICAL and ELECTRONIC COMPONENTS

Coaxial Triodes

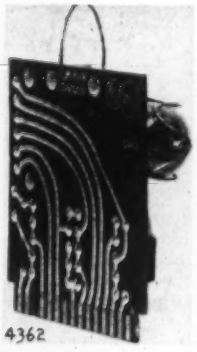
New "ML-6420 and ML-6421" coaxial-terminal triodes, employing new thoriated-tungsten filaments, are for



industrial (as well as broadcast) equipments of 5 to 10 kw. power output. As replacements for types 5666 and 5667, they provide improved performance ratings, safety margins and strength.—*Machlett Labs., Springdale, Conn.*

For more information circle **341** on inquiry card.

Plug-in Flip-flop



New "Z-91000" etched-circuit light-weight plug-in unit is a medium-speed bistable multivibrator for use in counting, frequency division, switching and time selection. Output of one can be directly coupled into another without amplifiers. Operates in range 0 to 100 kc.; requires 200 v.dc. at 3.5 ma. and a filament of either 6.3 or 12.6 v. (Other units to customer specs.). Weight 1½ oz.—*EECO Production Co., 827 S. Vermont, Los Angeles 5, Calif.*

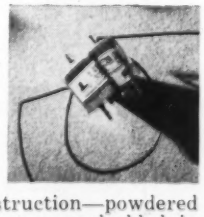
For more information circle **342** on inquiry card.

Variable Inductors

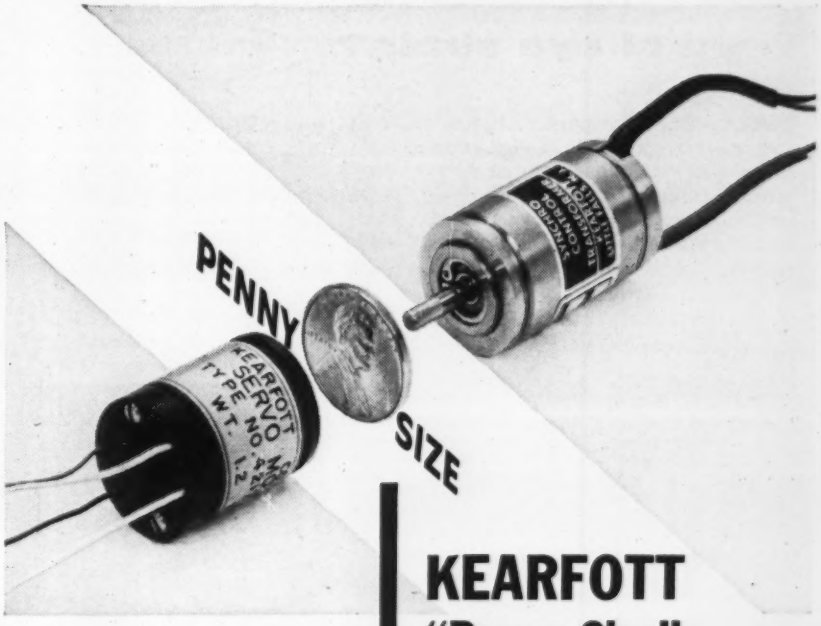
New "Style B Type 1" carbonyl-iron cup-core units embedded in epoxy are available in 16 standard values from 56 uh. to 18 mh.; are tunable over a 2:1 inductance range; have voltage ratings of 400 and ratings of 5 watts at 20 C. rise. Special units up to 200 mh.; also complete sealed tuned circuits with shunt capacitors.—*Levinthal Electronic Products, Inc., 2905 Fair Oaks Ave., Redwood City, Calif.*

For more information circle **343** on inquiry card.

I-F Transformers



New miniature intermediate-frequency transformers for instrumentation are available for 262, 455, and 1525 kc.; withstand large amplitude vibration and shock because of their construction—powdered carbonyl-iron cup cores embedded in epoxy resin. Electrically, double-permeability-tuned units feature unusu-



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SYNCHROS

- ¾" Diameter x 1.240" long
  Transmitter, Control Transformers, Resolvers and Differentials
  10 minute maximum error,
  26 volt, 400 cycle excitation

Straight thru bore and potted stator construction provide environmental resistance and high order of performance to these Motors and Synchros. Technical data sheets sent on request.

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For more information circle **80** on inquiry card.

Tired of eye strain?

Eliminate tedious manometer tube readings from your operations *now!* CEC's *all-electronic* 37-103 Electromanometer equals the mercury manometer in accuracy (0.05% of full scale) and gives you many important advantages. Whenever a fast, accurate pressure standard is required, investigate this new method of pressure measurement . . . send for Bulletin CEC 1547-X1.

- fast response time
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37-103 Electromanometer . . . interchangeable pressure heads (right) are offered in 5, 15, 60 and 150 psi ranges, can measure gage, differential or absolute.

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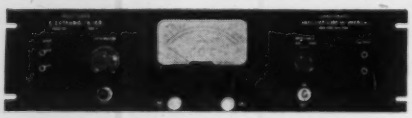
For more information circle **81** on inquiry card.

For High Precision Measurements Depend on . . .

AMPLICORP ELECTRONIC FILTERS and TUNED AUDIO AMPLIFIERS



Developed to help meet the long apparent need for improvement in measurement accuracy and control sensitivity of networks involving single frequency circuits.

When added to a laboratory oscillator, the new type EF Electronic Filter will reduce distortion to less than 0.01% which makes it suitable for significant intermodulation or frequency distortion measurements.

When a type "A" Tuned Amplifier is inserted between a bridge balancing network and its indicator or control circuit, it will increase sensitivity of measurement by a factor of 1000 to 1

In contrast to previously available null detectors, the noise level of this tuned amplifier is less than 1 microvolt referred to its input terminals.

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For more information circle **82** on inquiry card.

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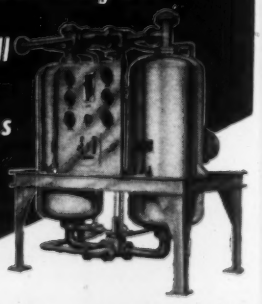
with all the features



- ★ Exclusive Finned System Desiccant Chambers
- ★ Automatic, Semi-Automatic, or Manual Control
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- ★ Atmospheric and Pressure Regeneration Circuits
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Submit your Dryer problems to our experienced instrument engineers.

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For more information circle **83** on inquiry card.

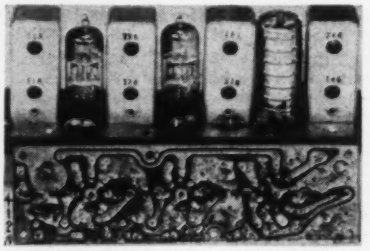
NEW INSTRUMENTS

ally constant inductance, freedom from non-linear effects; and wide tuning range.—*Levinthal Electronic Products, Inc.*, 2905 *Fair Oaks Ave., Redwood City, Calif.*

For more information circle **344** on inquiry card.

I-f. Strip

New "PC-4" printed circuit i-f. strip for use in monochrome sets with sound carrier i-f. frequency of 41.25



Mc. and video carrier i-f. frequency of 45.75 Mc., combines established printed circuit techniques with progressive circuit design.—*Allen D. Cardwell Electronics Production Corp., Plainville, Conn.*

For more information circle **345** on inquiry card.

Adjustable-lead Networks

New "DCA-1" adjustable lead networks provide approx. 60 deg. of peak phase lead at low signal frequencies characteristic of servomechanisms. Novel feature: a single control adjustment permits setting peak lead angle at any point in a frequency range of approx. 3 to 1. D-c. gain and amount of phase lead are unaffected by adjustment. Networks are small plug-in units.—*Computer Development Corp.*, 134-43 231 *St., Laurelton, N. Y.*

For more information circle **346** on inquiry card.

Microwave Antennas

Eight new models of maker's Microwave Antennas cover frequency spectrum from 380 to 10,800 Mc. Six variations of one type (helical radiators) cover 380 to 5,000 Mc.; two variations of other type cover 4750 to 10,800 Mc.; these have waveguide inputs transitioned into round flush-mounted horns containing phase shifters for producing elliptical polarization; can also be supplied with ridged waveguide input. General specs include: VSWR less than 2:1; voltage ellipticity ratio less than 2:1; half-power beam width greater than 45 deg.—*Dalmo Victor Co.*, 1440 *El Camino Real, San Carlos, Calif.*

For more information circle **347** on inquiry card.

Microwave Absorbant

New "Type T" microwave absorbing material (recently declassified by government), is an improved version of maker's "F-89VF." Typical X-band material comes in 18 x 36 in. sheets, weighs 0.25 lb./sq.ft., is about 0.1 in. thick, aluminum-backed and easily mounted with standard adhesives. It can be designed to have same absorption characteristics at two unrelated frequencies, such as 22,000 and 9,500 Mc.—*McMillan Industrial Corp., Brownville Ave., Ipswich, Mass.*

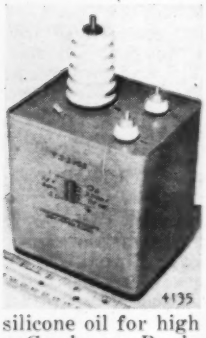
For more information circle **348** on inquiry card.

Submin. Trimming VDR

New "Tiny Trim," said to have been miniaturized to "half the size of the smallest previous trimming potentiometer," features flat design and location of adjusting screw in narrow edge, whence numerous combinations of stacking into compact banks. Standard resistance ranges from 10 to 25,000 ohms; other ranges special. Winding is done under constant inspection with a 30-power microscope, whence optimal linearity. Adjustment ratio 80 to 1. Units withstand shock and acceleration to 100 *G*, temperatures to 250 F., moisture and corrosion.—*Daystrom Potentiometer Div., Daystrom Pacific Corp., 1509 Colorado Blvd., Santa Monica, Calif.*

For more information circle **349** on inquiry card.

H-v. Transformers



New high-voltage oil immersed transformers, for use in test equipment and power supplies, are made in both 60- and 400-cps. types up to a 5 kva. power level; are impregnated with conventional types of high dielectric strength transformer oils, as well as with silicone oil for high temperature uses.—*Condenser Products Co., 140 Hamilton St., New Haven, Conn.*

For more information circle **350** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Magnetic Resolver

New "Series 1800" features unusually rapid response to step function waves, yielded by specially-processed high-permeability steel core. Unusually low brush noise level makes it specially suited for driving circular sweep radar presentations. Vector sum of output voltages of quadrature rotor windings is constant in amplitude within 0.5 percent and at an electrical angle within 30 minutes of resolver shaft. Special design features can be incorporated.—*Avionic Div., John Oster Mfg. Co., Racine, Wis.*

For more information circle **351** on inquiry card.

Synchro

New "R900" synchro features: (1) mechanical stability: stator integrally bonded with housing prevents null shifts when rotating or clamping synchro in its mount. All materials have similar thermal coefficient of expansion; (2) corrosion resistance; (3) high accuracy: 10 minutes maximum deviation spread from electrical zero. Optional configurations are available

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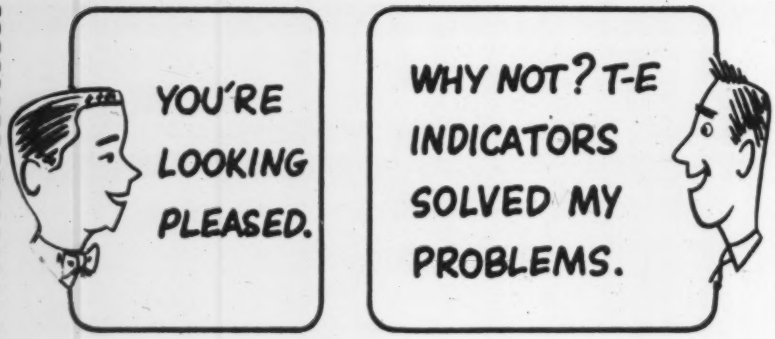
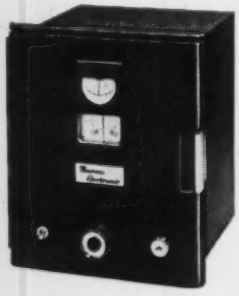


If you want to read temperatures accurately, use a T-E indicator: self-balancing or manual-balance, whichever suits your operation. Both of them are made in 2 types, potentiometer pyrometer and resistance thermometer. They are rugged, simple in design, and easy to maintain. 23 ranges from −320° to +200°F all the way to 0 to 3000°F. Connections are made through toggle switches, rotary switches, or quick-coupling connector panels.

SELF-BALANCING INDICATOR

For checking many points rapidly. Easy to read (34" scale with widely spaced graduations), fast (full scale travel 4 seconds), sensitive (1/20 of 1% of scale range), and accurate (±¼ of 1% of range).



MANUAL-BALANCE INDICATOR

For research and testing applications. Extremely sensitive (resistance thermometer type can measure changes as small as 0.02°F) due to its electronic galvanometer, accurate (better than ¼ of 1% of scale), and rugged.

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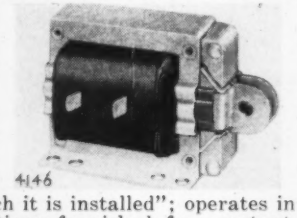
For more information circle **85** on inquiry card.

with leads or terminals, single or double ended shafts. 26- or 115-volt excitation, high or low impedance.—*Kearfott Co.*, 1378 *Main Ave., Clifton, N. J.*

For more information circle **352** on inquiry card.

Heavy-duty Solenoid

New small solenoid, incorporating novel positioning of double shading coil for high seated pull, is said to be "engineered to outlast the product in



which it is installed"; operates in any position; furnished for constant and intermittent duty. 115 v.ac.—*Dormeyer Industries*, 3418 *N. Milwaukee Ave., Chicago* 41, *Ill.*

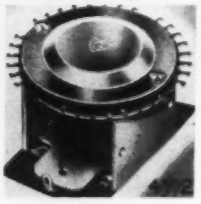
For more information circle **353** on inquiry card.

Nylon Plug Adaptor

New "Model 1416" phone plug adaptor of molded nylon withstands rigors of field service, was developed and manufactured for Signal Corps, is now released for civilian use.—*Industrial Devices, Inc., Edgewater, N. J.*

For more information circle **354** on inquiry card.

32-pole D-c. Relay



New "Series 805" d-c. relay weighs under 5 oz.; can simultaneously connect together 32 electric circuits. Individual contact blades molded in thermosetting phenolic; all contacting members completely enclosed in an aluminum cover.—*Guardian Electric Mfg. Co.*, 1261 *W. Walnut St., Chicago* 12, *Ill.*

For more information circle **355** on inquiry card.

Telephone-type Relays

New "Type A" telephone relays, for applications requiring rapid opening and closing of up to 14 individual circuits, feature d-c. operation; coil resistance up to 63,000 ohms; coils single or double wound; single or double armatures; maximum coil dissipation 10 watts.—*Kurman Electric Co.*, 35-18 *37th St., Long Island City, N. Y.*

For more information circle **356** on inquiry card.

A-c. or D-c. Relay

New "Series 23" relay has a flexible armature and contacts easily readjustable after being placed in service; is highly sensitive (30 mw.); is said to exhibit excellent high-speed keying characteristics; weighs less than 2 oz. Coil resistances up to 5000 ohms; maximum continuous coil dissipation 1 watt. Adjustable sp.dt. contacts rated 1 amp. 110 v.ac.—*Kurman Electric Co.*, 35-18 *37th St., Long Island City, N. Y.*

For more information circle **357** on inquiry card.

Sensitive Relay

New "100-B" d-c. relay is available hermetically sealed or with dust cover; features low wattage consumption: 25 milliwatt per contact together with wiping action. Heretofore, it is said, this characteristic has not been available on relays of this type. If desired, drop-out can be adjusted to about 65 percent of pick-up. Capacity up to 1 amp. inductive and 3 amp. resistive load with coil resistance to a maximum of 30,000 ohms. Available in spst up to dpdt contacts. Diameter 1¼ in.; 3⅝ in. above mounting line.—*Hedin Tele Technical Corp., 640 West Mt. Pleasant Ave., Livingston, N. J.*

For more information circle **358** on inquiry card.

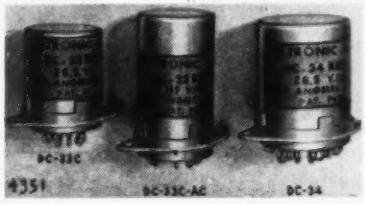
Miniature Relays

New subminiature "CPL" relays, for application where low and high temperatures are a major factor, are hermetically sealed, are available in spdt. (CPL-1) and dpdt. (CPL-2), contact ratings to 5 amps. resistive at 28 v.dc. 115 v.ac. or 3 amps. inductive; vibration 15 *G* through 500 cps.; shock 50 *G*.—*Pacific Relays, Inc., 6819 Melrose Ave., Los Angeles 38, Calif.*

For more information circle **359** on inquiry card.

Miniature Relay

Three new miniaturized relays, added to maker's line, are designated "Part Nos. DC-34," featuring unique

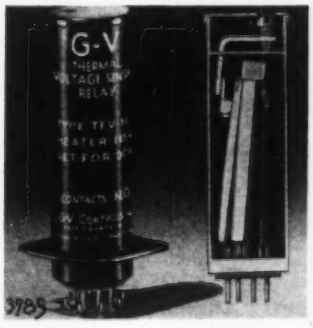


non-energized armature locking device, and "DC-33C" and "DC-33C-AC," with positive snap-action switch contacts. All units are evacuated, filled and sealed with inert gas, making coil and contacts impervious to dust, corrosion and moisture.—*Deltronic Corp., 1507 Riverside Drive, Los Angeles 31, Calif.*

For more information circle **360** on inquiry card.

Thermal Relays

New complete series of thermal-type current-sensing and voltage-sensing relays: nine different internal structures; time constants from 1 sec. to 2½ min. Units operate interchange-



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For more information circle **86** on inquiry card.

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CAPACITORS
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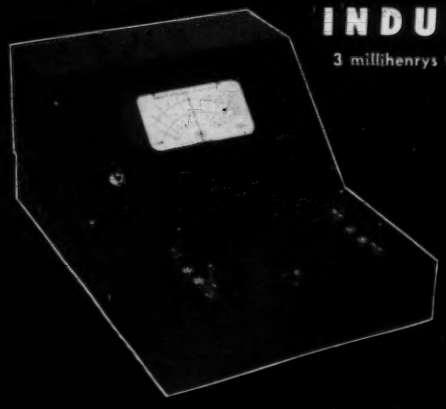
INDUCTORS
3 millihenrys to 10,000 henrys



Sloping meter face and wide-spaced component clips speed production line testing. Foot operated switch* allows two-hand operation.

Stable, high-gain, circuit permits the detection of component differences amounting to only 1 part in 10,000. Five meter ranges indicate differences at 1%, 2.5%, 10% and 25% value full scale.

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For more information circle **87** on inquiry card.

ably on dc. or on ac. of any frequency; withstand shock and other military environmental tests. Contact rating 3 amps. at 115 v.ac. non-inductive or at 28 v.dc. non-inductive; close or open on current or voltage rise. Operating currents from 0.015 to 5 amps. and voltages from 1 to 230.—*G-V Controls Inc., 28 Hollywood Plaza, East Orange, N. J.*

For more information circle **361** on inquiry card.

15-amp. Midget Relay

New "Series 595" d-c. telephone type relay is available with heavy-duty contacts. Unit can withstand an inrush current of 50 amps. at 28 v.dc. and is rated for continuous operation at 15 amp. 28 v.dc. Standard 3-amp. auxiliary contacts can also be supplied. Approx. 1¼ in. long, unit weighs 2½ oz. —*Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.*

For more information circle **362** on inquiry card.

Coaxial Relay

New moving coil relay design features advantages of maker's Coaxial Mechanism; is hermetically sealed; mounted on standard 7 pin tube base; weighs 1½ oz.; 13/16 in. diam.; 1-13/16 in. over-all.—*Marion Electrical Instrument Co., Manchester, N. H.*

For more information circle **363** on inquiry card.

Rectifier Relay

New "Type 8AC" has its own rectifier, eliminating exterior wiring. Rectifier occupies fraction of an inch of space adjacent to the coil. One section of rectifier is for half-wave control; other shunts coil to prevent a-c. vibration. New relay can operate 4 Form C up to 55 C., whereas usual 400-cycle relay operates only 1 Form C.—*Phillips Control Corp., Joliet, Ill.*

For more information circle **364** on inquiry card.

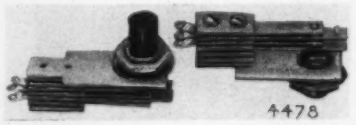
Hook-up Wire

New Hook-up Wire features extruded Teflon insulation to provide "super service performance wherever abrasion or a wide range of temperatures are encountered." Solid and stranded conductor types available. Sizes from 10 to 32 AWG. Choice of ten colors; wall thicknesses 10 or 15 mils.—*Tensolite Insulated Wire Co., Inc., 196 Main St., Tarrytown, N. Y.*

For more information circle **365** on inquiry card.

Flat-frame Switches

New "NF-switches" utilize a smaller spring design, minimizing entire size of switch. Rugged flat frame is

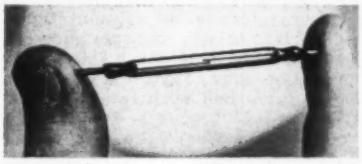


readily adaptable to any "pile-up" of contact springs. Seven standard circuits: single "make"; single "break"; single "break-make" s.p.d.t.; two "makes"; two "breaks"; two "break-makes" d.p.d.t.; three "break-makes" 3pdt (3 form C).—*Switchcraft, Inc., 1328 N. Halsted St., Chicago 22, Ill.*

For more information circle **366** on inquiry card.

Sealed Magnetic Switch

New magnetically-operated glass-enclosed dry-reed switch with operating time of one millisecond or less,



operates in any position at temperatures from –85 F. to 500 F. and at rates as high as 400 per second. Rhodium-plated contacts operate in an inert gas, are rated 0.5 amp. resistive or inductive at 28 v.dc. or 10 watt lamp load at 115 v.ac.—*Revere Corp. of America, Wallingford, Conn.*

For more information circle **367** on inquiry card.

Limit Switches

New major design improvement has been effected in "Loxswitch Series L100," heavy-duty limit switches used for automatizing machine tools and conveyors, in order to provide 70 deg. overtravel without use of cams, levers, or extra springs. Switch maintains the same trigger-type mechanism and overtravel is provided in either direction. Available as s-p.d-t., n-o. or n-c. in either direction; or d-p. with both circuits n-o. or n-c.; and with 3-p., two closed, one open, or vice versa.—*R. B. Denison Mfg. Co., 102 St. Clair Ave., N.W., Cleveland 13, Ohio.*

For more information circle **368** on inquiry card.

MOTORS, ETC.

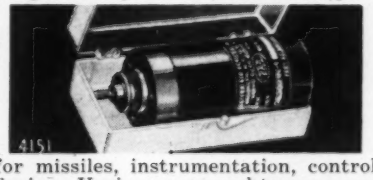
Miniature Motors

New "Frame 43" miniature high-power motors, said to be "the most powerful of their size yet produced for continuous-duty Class A service," are available as hysteresis or induction units. Improved design and built-in "air conditioner" give low temperature rise with ratings up to 1/6 hp. in a frame 4⅜ in. diam. by 5½ in. long.—*Instrument Motors, Box 5, Acosta St., Stamford, Conn.*

For more information circle **369** on inquiry card.

Miniature Gear-motor

New servo gear-motor, 1⅛ in. diam., weighs barely 4¼ oz.; is well adapted



for missiles, instrumentation, control devices. Various rpm. and torque combinations. Hysteresis, synchronous and capacitor induction motors at various voltages and frequencies.—*Eastern Air Devices, Inc., Central Ave., Dover, N. H.*

For more information circle **370** on inquiry card.

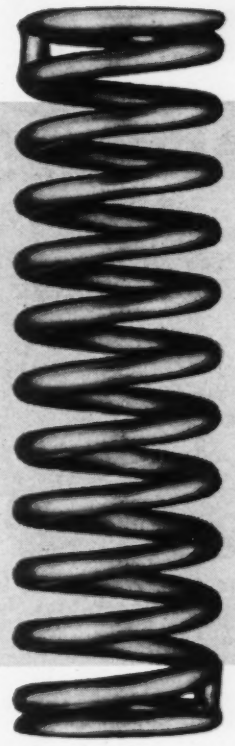
Motor-generator Sets

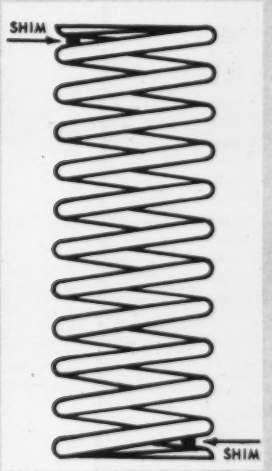
New "Series 400" meet demand of aircraft and related industries for 5-kw. to 100-kw. supplies that deliver exactly 400 cps. regardless of load

it's the shim that counts in

CHATILLON COMPRESSION SPRINGS

Available in practically all sizes and capacities





Chatillon's compression springs with calibrated shims—an original Chatillon development—perform so accurately, they are specified in the precision instruments of leading manufacturers: e.g.: General Electric (ordnance equipment), Bendix (pressure transmitters), Chandler-Evans (aircraft carburetors). Shims brazed on the end coils of this spring maintain constant number of active coils during compression, thereby insuring constant rate. Straight line relationship between load and deflection is considerably improved. This great increase in accuracy, costs no more! Chatillon compression springs are available in Iso-Elastic* (Chatillon's own temperature-compensated alloy) or other spring alloys. Chatillon also manufactures Spiral, Torsion and Form Springs in Iso-Elastic and conventional alloys.

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85 Cliff Street, New York, N. Y.

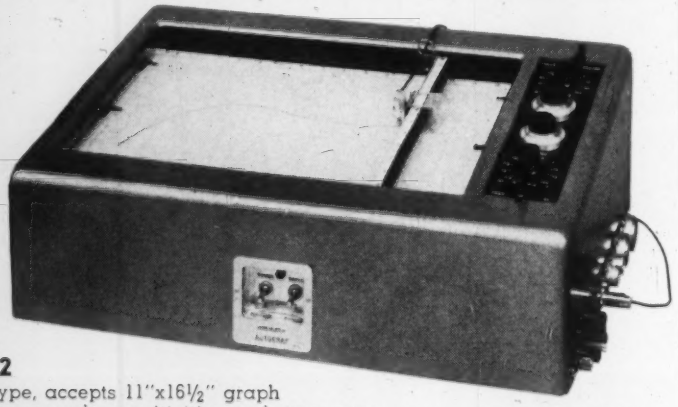
Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **88** on inquiry card.

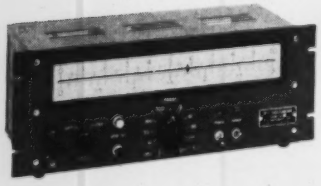
THE MOSELEY
AUTOGRAF
trade mark
X-Y RECORDER

MODEL 1. drum type, accepts 8½"x11" graph paper; traverses each axis in 1 second; has full scale ranges of 5 millivolts to 100 volts; zero set anywhere on the paper; portable, self-contained; available also as a curve follower for electrical read-out of drawn curves.

AUTOGRAF Recorders, MODELS 1 and 2, provide all the features needed for graphic recording of test data, point plotting, and curve following for readout purposes.

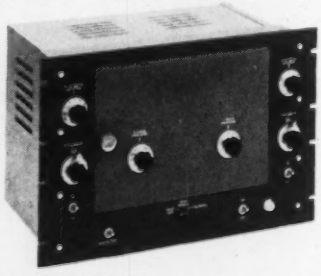


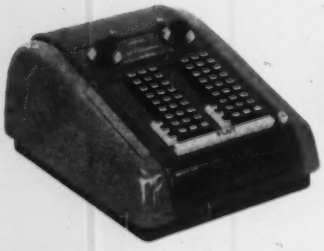
MODEL 2
Flat bed type, accepts 11"x16½" graph paper; same speeds, sensitivities and ranges as MODEL 1; zero set anywhere on paper plus one full scale length of zero-offset; inputs provided for analog recording, point plotting from digital sources, and curve following for computer or data reduction use.



MODEL 20 DC VOLTMETER is a servo-actuated, fast, accurate and sensitive instrument. Has large, easy-to-read scale for general laboratory use where ranges from 3 millivolts to 300 volts are desired. For data handling it is furnished with a built-in Coleman digitizer and delivers digital output for operation of printers, typewriters, tape or card punches, etc.

MODEL 30 CARD TRANSLATOR converts information from punched cards into point form for automatic plotting. Handles up to 50 cards per minute, 10 to 200 counts per inch. Plugs directly into MODEL 2 recorder, controls both card reader and recorder for completely automatic operation.





MODEL 40 KEYBOARD provides a convenient means for plotting large amounts of tabular data in point-curve form. Self-contained voltage source together with full three column keyboard in both X and Y axes; unit plugs directly into MODEL 2 AUTOGRAF.

Bulletins describing these instruments are available and we'll be glad to send them to you. Write . . .

F. L. MOSELEY CO., 409 North Fair Oaks Avenue, Pasadena 3, California

For more information circle **89** on inquiry card.

or input line voltage variations. Voltage control system has no moving parts; requires no adjustments and is said to be entirely maintenance-free. Response time 0.015 to 0.150 sec. depending on power factor of load. Units can be furnished with total harmonic as low as 0.25 percent.—*Palmer Electric Co., 6629 Bear Ave., Bell, Calif.*

For more information circle **371** on inquiry card.

Dual-purpose Generator

New "GPM-3" produces a two-phase indicating sine-wave, and two 10-degree pips 180 degrees apart, coordinated to one of the phases; delivers a 13-v. 20-cps. output at 1200 rpm.;

current rating 0.015 amp. per phase; 300-ma. peak current rating of pip-generating switch. Weight 19 oz.; 4-in. over-all length.—*Dalmotor Co., 1344 Clay St., Santa Clara, Calif.*

For more information circle **372** on inquiry card.

Induction Motor

New "AC-93 Miniature Sub-fractional Induction Motor" has application characteristics for magnetic tape recorder operation; servo or actuator motor; and geophysical-equipment. Although standard unit is an induction motor, its design is such that it can be supplied with minor changes, as a synchronous unit with reduced power output. Operating at 115 volts, 400-cps, 1-phase, the unit has an rpm of 11,800 with a 15-watt output. Locked rotor torque is 1.8 oz-in minimum. Maximum power input is 45 watts and rotation is reversible.—*Dalmotor Co., 1344 Clay St., Santa Clara, Calif.*

For more information circle **373** on inquiry card.

Actuator Motor Unit

New horizontal stabilizer actuator unit for aircraft application comprises stabilizer drive which mounts both 110-v.ac. 400-cps. and 24-v.dc. motors for optional operation, providing three speeds for manual, autopilot and coarse control.—*Western Gear Works, P. O. Box 192, Lynwood, Calif.*

For more information circle **374** on inquiry card.

PM Generator & SM

New permanent-magnet type generator is mounted coaxially with a standard 2-phase servomotor; 0.98-in. diam. x 2.56 in. long; has output voltage gradient which can be as high as 20 v./1000rpm. Output frequency depends on speed of generator, which has a 4-pole winding. Servomotor can be operated from single- or 2-phase supply, can be wound for 400- or 60-cps. applications; torque about 0.15 oz.-in. depending on power input, frequency, and speed of motor.—*G-M Laboratories, Inc., 4300 North Knox Ave., Chicago 41, Ill.*

For more information circle **375** on inquiry card.

Frac.-hp. Motor

New explosion-proof fractional-horsepower motor will give ten-years' normal service without relubrication. —*General Electric Co., Schenectady 5, N. Y.*

For more information circle **376** on inquiry card.

Miniature Gear-motor

New "Type 3094" motor and gear train features fact that motor and gear train are not separate entities but a single homogeneous unit, minimizing space and weight (10½ oz., 1½ in. diam. and 3½ in. length for entire unit at a ratio of 523:1). Any ratio from 3:1 to 10,500:1. Exceptionally high torque in relation to size and weight: examples are 100 lb.-in. at 523:1 and 1600 lb.-in. at 10,500:1. —*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **377** on inquiry card.

Miniature Gear-motors

New gear heads are available in a full range of gear ratios for maker's "1600 Frame" sub-fractional-hp. motors; are designed to meet any precision low-speed high-torque requirement; withstand impact, vibration and high acceleration. Actuating devices for special control problems incorporated when requested. "1600 Frame" motors are available in induction or synchronous types, standard or self-cooled, 60- or 400-cps. or variable frequency (50-1600 cps.), single or polyphase, in ratings from 1/1000 to 1/10 hp.—*Induction Motors Corp., 570 Main St., Westbury, L. I., N. Y.*

For more information circle **378** on inquiry card.

MECHANICAL COMPONENTS

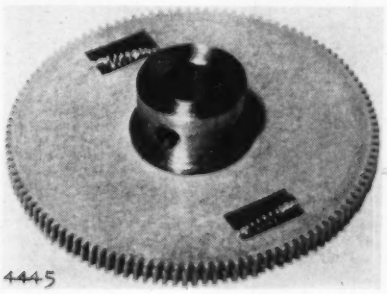
Cable & Tube Support

New "Twist-Rack" supporting structure is easily assembled by "a twist of the wrist"; is used to hold "Cabletrof," "Tubetrof," conduit, shelving, cables, pipes, etc.—*P-W Industries, Inc., Duncan & Melrose Sts., Philadelphia 24, Pa.*

For more information circle **379** on inquiry card.

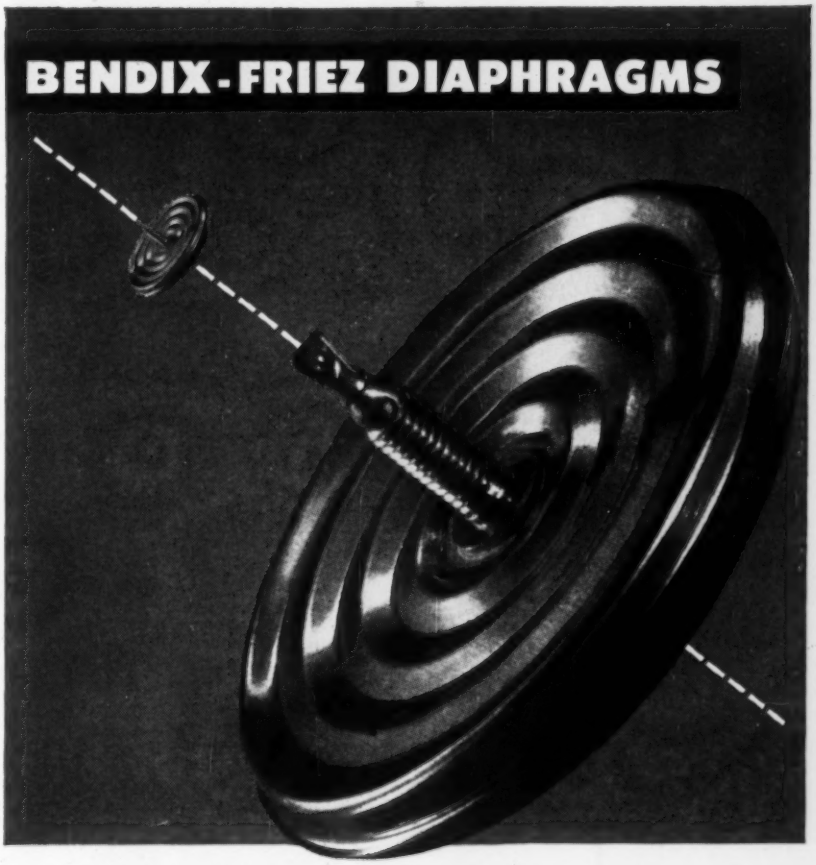
Anti-backlash Gear

New "Type No. P2" gear assembly, for use where zero backlash is required, has stainless steel springs to take up backlash. Two aluminum annodized gears can be rotated in opposite directions until they engage firmly with mating gear; then, regardless of direction of rotation, there is no backlash. Three standard adapters for



4445

BENDIX-FRIEZ DIAPHRAGMS



AVAILABLE IN ALL TYPES AND SIZES FROM ½" DIAMETER UP

Whatever your needs or requirements in diaphragms may be, chances are Bendix-Friez* *already* has the answer for you. When it comes to size, you'll find a wide range from ½" diameter up. In manufacturing technique, we make diaphragms with soldered or welded seams. And to suit your particular application, we have a wide variety of standard model diaphragms with various studs and end-fittings.

Can be stacked

Bendix-Friez diaphragms can be stacked when it's necessary to provide a multi-diaphragm power unit for more actuating energy. They can be made linear with pressure or linear with altitude, as required. In addition, they can be made to cover a wide range of military and environmental specifications with reference to temperature, vibration, humidity, etc.

In variety of uses

Bendix-Friez diaphragms are turning in dependable performance records in instruments of all kinds—barometric pressure switches—pressure transducers—telemetering equipment—plus many other difficult applications. Perhaps you have a problem in diaphragms. Let us put our nearly 20 years of research and development in this specialized field to work for you. Your inquiry is invited.

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Friez INSTRUMENT DIVISION BALTIMORE 4, MD.

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 205 E. 42nd St., New York 17, N.Y., U.S.A.

For more information circle **90** on inquiry card.

Model E-6-15A Nobatron

WHEN YOU NEED
PRECISELY REGULATED DC

SPECIFY
NOBATRON*

accurate • dependable • economical

For more than ten years, Sorensen NOBATRONS have provided regulated, low-voltage, high-current DC in thousands of laboratory and industrial applications. Their users have chosen them for their ±0.2% regulation accuracy, their convenience of use compared with battery installations or other sources, their dependability, their easy maintenance.

Nobatron circuits usually employ only three tubes. They are easily accessible for replacement when required. The characteristics listed below are conservative and tell you why you should specify Nobatron.

Models available (numbers indicate voltage & current) E-6-5A, E-6-15A, E-6-40A, E-6-100A, E-12-5, E-12-15, E-12-50, E-28-5, E-28-10, E-28-30, E-28-70, E-28-150, E-48-15, E-125-10, E-200-5.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1φ, 50-60 cycles. 120/208, 3φ, 4-wire wye for the E-28-150. The E-28-70 requires 190/260, 1φ power.
Reg. accuracy	±0.2% against line, ±0.2% against load.
Ripple	Varies to 1% RMS max. under worst conditions.
Load range	1/10 to full load.
Output range	Adjustable ±10%; down to 20% at lesser accuracy.
Recovery time	0.2 seconds on all models up to 1 KW rating, increasing to 0.5 seconds at 10 KW.

Note: "A" models output either 6 or 7 volts. *Reg. U.S. Pat. Off.

Model SR2

NOBATRON-RANGERS Your interests may best be served by an instrument with electrical characteristics similar to the standard Nobatron, but with stepless, continuously adjustable output. If so — find out more about Sorensen's line of Nobatron-RANGERS.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1φ, 50-60 cycles for SR30 and SR100. 190-260 VAC, 1φ, 50-60 cycles for the SR2.		
Reg. accuracy	±0.25% at any voltage setting.		
Ripple	1% RMS max.		
Output: Model	SR100	SR30	SR2
VDC	5-135	5-30	100-300
Amps	1-10	3-30	1-10

TUBELESS NOBATRONS Sorensen is aware of the advantages of tubeless circuitry, and manufactures a line of tubeless supplies, also.

ELECTRICAL CHARACTERISTICS

Model	MA65	MA640	MA2850
Input, VAC, 60~	105-125, 1φ	105-125, 1φ	190-230, 3φ, 4-wire, wye
Output, VDC	6, adj. ±10%	4.5-7.7 adj.	23-32 adj.
Load range	0-5 amp.	0-40 amp.	0-50 amp.
Ripple	1% max.	1% max.	3% max.
Reg. accuracy	±1.0% for any combination of line and load.		
Recovery time	0.2 sec.	0.15 sec.	0.5 sec.

Model MA640

Catalogs available describing the complete line of Sorensen instruments. Write for free copies today.

SORENSEN

SORENSEN & CO., INC., 375 FAIRFIELD AVENUE, STAMFORD, CONNECTICUT

For more information circle **91** on inquiry card.

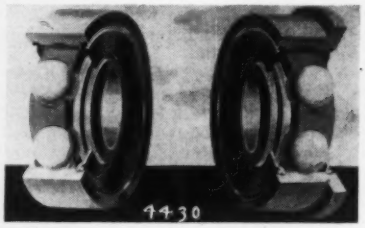
NEW INSTRUMENTS

⅛, 3/16 and ¼ in. shafts. Available from stock in many pitches and numbers of teeth.—*PIC Design Corp.*, 160 *Atlantic Ave., Lynbrook, L. I., N. Y.*

For more information circle **380** on inquiry card.

Instrument Bearings

New types of "Micro Retainer Radial Bearings" are available with single or double side shields for added

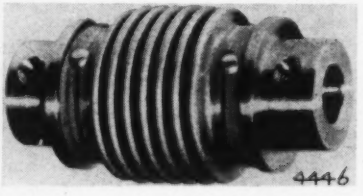


protection against contamination during installation and use. Metallic type shields can be removed for cleaning bearing. Types include straight and flanged outer rings.—*New Hampshire Ball Bearings, Inc., Peterborough, N. H.*

For more information circle **381** on inquiry card.

Bellows Coupling

New "Type No. T1 Precision Bellows Coupling" for joining shafts of the same or different diameters where



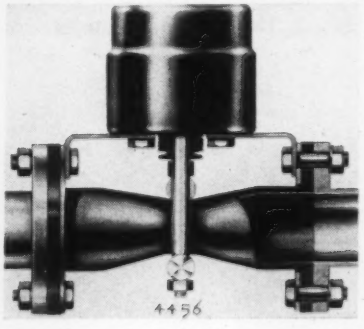
low torque operation is required, features stainless steel bellows action permitting a reasonable degree of angularity and misalignment. Designed for 3 basic shaft sizes ⅛, 3/16 and ¼ in. Six different shaft-to-shaft combinations immediately available from stock.—*PIC Design Corp.*, 160 *Atlantic Ave., Lynbrook, L. I., N. Y.*

For more information circle **382** on inquiry card.

VALVES

Pinch Type Valves

New flanged valves for handling corrosive materials or abrasive slurries, wet or dry, are of straight-through-flow pinch type. "Series Rx" (high pressures) and "Rz" (low pres-

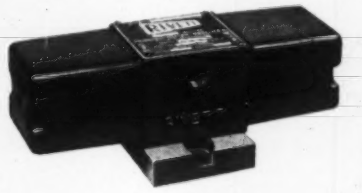


sures) can be had with positioner for flow control if desired. Rolling diaphragm type air motor is rated for 125 psi. air operation. Sizes from ¼-in. to 14-in.; maximum 100 psi. line pressure; maximum of 180 F. operating temperature.—*R. K. L. Valve & Mfg. Co.*, 1623 *Elaine St., Phila.* 19, *Pa.*

For more information circle **383** on inquiry card.

Solenoid Valve

New "Series 6500" solenoid pilot valve for automatic control of hydraulic circuits is of sub-plate mounted



type for panel mounting; is conservatively designed for full 3,000 psi. Solenoids operate on 3.6 amps. inrush and 0.45 amp. holding at 115 v. Rated 3.6 gpm. at 15 fps. Seven spool designs available for any circuit control.—*Rivett Lathe & Grinder Inc., Brighton* 35, *Boston, Mass.*

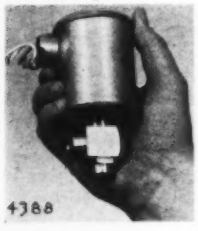
For more information circle **384** on inquiry card.

Solenoid Gas Valve

New gas valve is quiet in operation: power element resiliently mounted to a "Buna N" synthetic rubber base enclosed in a sound-deadening chamber; new synthetic-rubber seat with compression spring closure; radically new construction practically eliminates all transmission and radiation of sound to pipe, mounting structure, or outer valve casing, is said to make valve ideal for controlling wall and floor furnaces, unit heaters, conversion burners, etc.—*White-Rodgers Electric Co.*, 1209 *Cass Avenue, St. Louis* 6, *Mo.*

For more information circle **385** on inquiry card.

Solenoid Valves



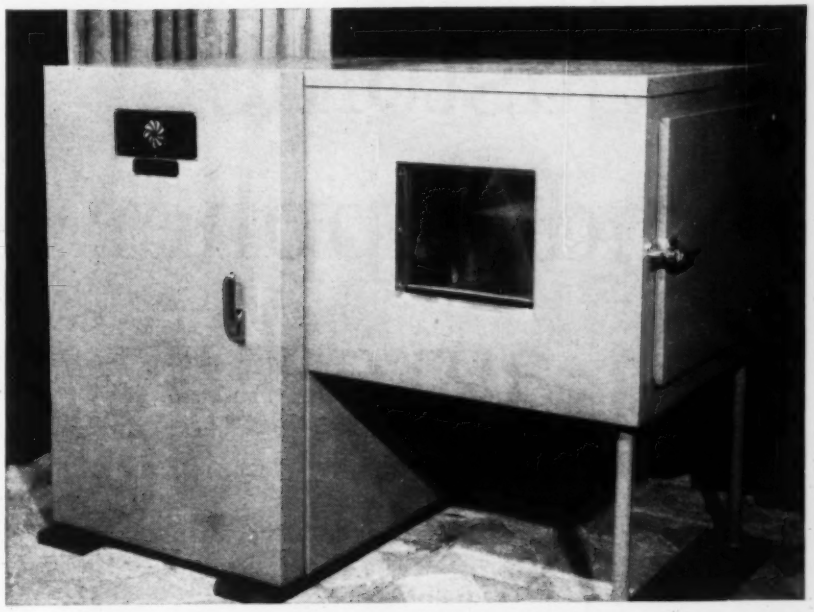
New direct lift solenoid valves made in brass "Type F" and stainless steel "Type G", come in ⅛-in. and ¼-in. pipe sizes, with ports from 1/16-in. to ¼-in.; feature unusually high maximum pressures: 1,000 psi. for air and gas; 600 psi. for water; 500 psi. for oil, and 200 psi. for steam. Valves have renewable metal seats; coils are interchangeable with those of maker's other valves, are unconditionally guaranteed for one year.—*J. D. Gould Co.*, 730 *E. Washington St., Indianapolis* 2, *Ind.*

For more information circle **386** on inquiry card.

Solenoid Valves

New 2-, 3-, and 4-way valves in ⅛-in. through ½-in. NPT sizes, are operated by a new solenoid, secondary-pilot-operating type, in which a relatively small solenoid controls a pilot cylinder for quickly shifting valve

NEW NIAGARA



AIR CONDITIONED TEST CABINET

USES—to determine effects of controlled temperature and humidity conditions on test subjects of all kinds—to test processes—to find optimum conditions.

RANGE—With water and electric power services only, the range is from freezing temperature up to 150° F (dry bulb). With refrigeration, and using Niagara No-Frost Liquid to prevent freezing of sprays, you achieve dew point temperatures as low as minus 30° F. Control of relative humidity from 5% to 95% is obtained at all temperatures in this range. Air capacity is 200, 400 or 600 c.f.m.

METHOD—Air is saturated in the air-conditioning unit at the required dew point temperature and reheated to the desired dry bulb temperature. This is the method of the Niagara Type A Air Conditioner which has been proven for the most exacting duty over twenty-five years.

CONTROL—The dew point thermostat is located in the air stream, the dry bulb thermostat in the test cabinet. No moisture sensitive instruments are needed. Recorders may be used to obtain a complete record of conditions.

TEST CABINET—(inside) dimensions are 30" x 28" x 24" with access clear opening 26" x 22". Insulation is the equivalent of 4" cork.

AIR CONDITIONING UNIT is enclosed in an insulated cabinet adjoining the test cabinet. A door the full size of the cabinet wall gives complete access.

Write for Complete Information. Address Dept. IN

NIAGARA BLOWER COMPANY

405 Lexington Ave., New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

For more information circle **92** on inquiry card.

Customer and supplier agree...

that, for best results, magnetic performance be defined in terms of the simplest and most readily available instrumentation.

▪ Furthermore, customer and supplier must understand and agree upon all the details of the sampling and testing procedures which each will employ.

▪ At Magnetic Metals Company we take the greatest care in the development and supervision of our magnetic testing procedures. In our quality control we use production test equipment which is accepted throughout the industry as the best for the evaluation of magnetic amplifier cores.

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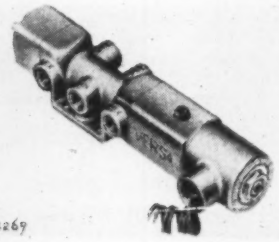
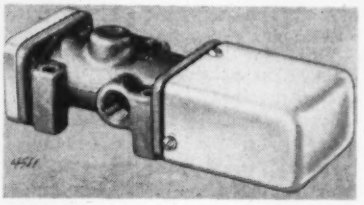


spool. No additional line is required for solenoid pilot cylinder (up to 150 psig.) since these valves are internally drilled to supply main-line air or fluids to solenoid pilot.—*Versa Products Co., Inc., 249 Scholes St., Brooklyn, N. Y.*

For more information circle **387** on inquiry card.

Solenoid Valve

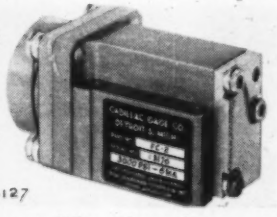
New "Bel-Air" valve line includes a new 3-way series as well as 4-way models. Solenoid-controlled, pilot-operated models offer a choice of 115, 230, or 440 v. operation. Same solenoid is used on all sizes.—*Bellows Co., Akron 9, Ohio.*



For more information circle **388** on inquiry card.

Servo Valve

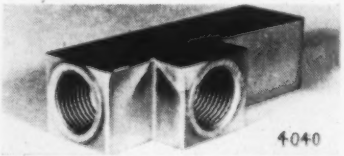
New "FC-2" controls hydraulic flow in proportion to input current signal; is 2-stage 4-way; pilot stage is a hydraulic amplifier of nozzle type driven by a torque motor employing polarized relay principle. Design is such that user requirements are easily obtained. —*Cadillac Gage Co., 20316 Hoover Rd., Detroit 5, Mich.*



For more information circle **389** on inquiry card.

Air-bleeding Valve

New automatic self-bleeding valve constantly bleeds air out of a hydraulic system while system is in operation; obviates need of manual bleeding, at time of installation, and throughout working life of system. Two required for every double-acting cylinder. On hydraulic brakes, however, only one



is required for entire system.—*Radial Metal Products, Inc.*, 1044 *Linwood St., Brooklyn* 8, *N. Y.*

For more information circle **390** on inquiry card.

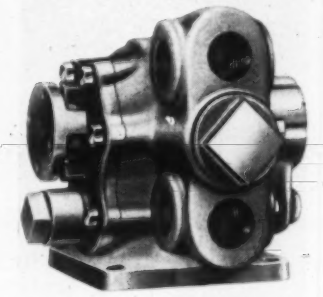
Three-way Valves

New "Model HF-3" hand-and-foot-operated 3-way valve of Venturi type has full-flow capacity of ¼-in ID pipe or equivalent of 50 cfm at 50 psi. Was designed for air, oil, and water up to 200 psi and is recommended for small single-acting cylinders.—*Airmatic Valve, Inc.*, 7317 *Associate Ave., Cleveland* 9, *Ohio.*

For more information circle **391** on inquiry card.

4-way Hydraulic Valve

New 4-way rotor-actuating valve "Cash Standard Type 555-RO" is a single, self-contained mechanism, actuates one to three hydraulic cylinders, is designed for 300-1500 psi pressures, with capacity of 400 gpm at 1500 psi.—*A. W. Cash Co., P. O. Box* 551, *Decatur, Ill.*



For more information circle **392** on inquiry card.

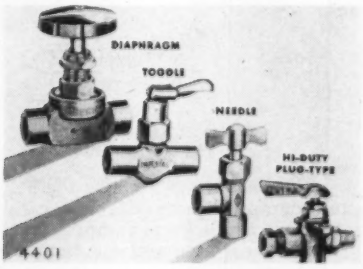
Multiport Relief Valves

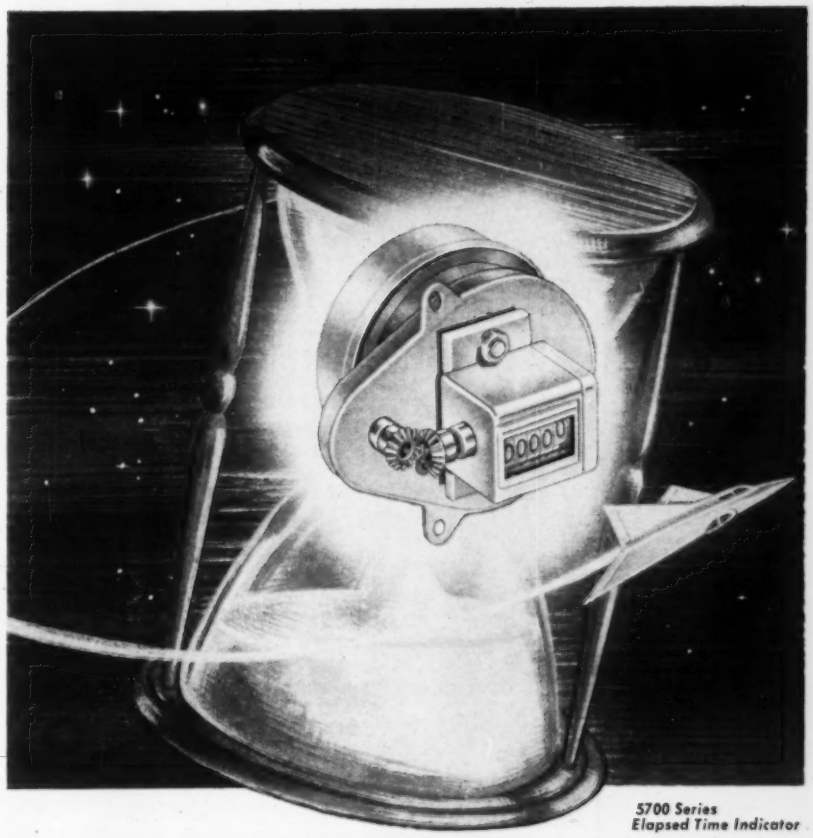
New "Multiport Relief Valves" are said to provide "unfailing operation under any conceivable service conditions," incorporate maker's unique vapor cushioned multiple valve disc design which causes valve discs to hold tight against operating pressures whether steady, fluctuating or pulsating, and open slowly only to extent required to bleed off overpressure. Sizes from 4 in. to 48 in. in vertical up-flow, horizontal or angle types. Ranges: 0-25, 0-60 and 0-100 psig.—*Cochrane Corp., Philadelphia* 32, *Pa.*

For more information circle **393** on inquiry card.

Hand Valves

New line of "Fluid Control Valves" comprises needle valves, toggle valves, "Hi-Duty" plug type valves and pack-





5700 Series
Elapsed Time Indicator

MEASURING THE COURSE OF TIME
with
HAYDON* TIMING DEVICES

TIME — and its measure — are positive factors in man's progress. And helping man to control this inescapable element, HAYDON has designed and developed small, rugged devices that track its course with precision and dependability.

If TIME is a factor in the progress of **YOUR** *product or process . . .*

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. . . HAYDON's complete Timing Services, engineering counsel and manufacturing facilities, are at your disposal.

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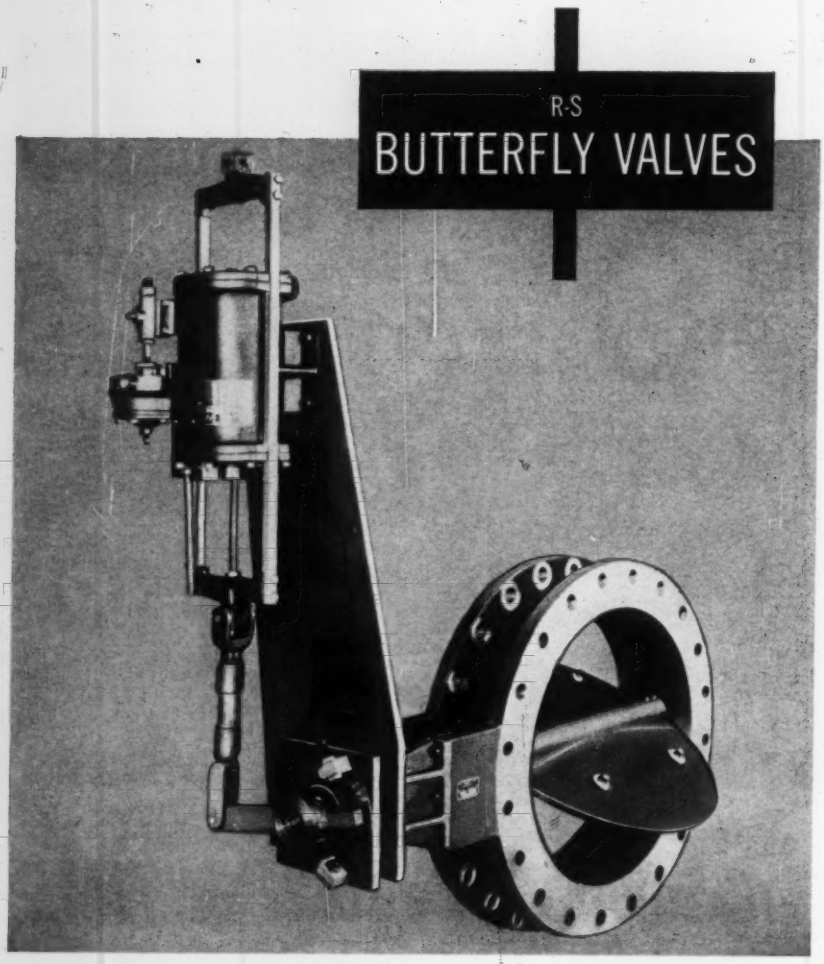
HAYDON Manufacturing Company, Inc.
2029 ELM STREET, TORRINGTON, CONN.

For more information circle **94** on inquiry card.



R-S VALVES FOR SENSITIVE CONTROL

These design features have won complete process control acceptance for R-S Butterfly Valves. Whether in chemical, refining, paper or power systems, an R-S Valve gives you every advantage in . . .

. . . complete control in all positions of normal regulating range
. . . fast regulation and fast control
. . . minimal pressure drop
. . . compactness and lightness at less cost

R-S valves with automatic controls assure the most positive and dependable performance obtainable.

S. Morgan Smith offers you better valve engineering for your control applications. Over 75 years experience in designing and engineering for the hydraulics field are at your disposal. To find the proper valve for any application problem, or to get more information on our complete line of butterfly, cone and ball valves, write to S. Morgan Smith Company, York, Pennsylvania.

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Butterfly Valves
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S. MORGAN SMITH CO.

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

For more information circle **95** on inquiry card.

less diaphragm valves; are especially designed for instrumentation, refineries, laboratories, pneumatic and vacuum systems, etc.; include models for panel mounting.—*The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.*

For more information circle **394** on inquiry card.

MISCELLANEOUS

Mercury Jet Switch

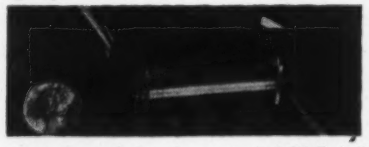
New high-speed commutating and sampling switch for monitoring 120 circuits 60 times per second utilizes

a mercury jet stream continuously emanating from a central pool and caused to sequentially contact pins located circumferentially around stator. No contact bounce; low noise level; potential of thousands of hours of continuous operation.—*Detroit Controls Corp., Res. Div., Redwood City, Calif.*

For more information circle **395** on inquiry card.

Integrating Gyro

New "HIG-3" is announced as "the smallest hermetically-sealed Integrating Gyro ever made, an outgrowth of

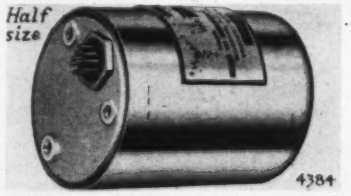


research and development of U.S.A.F. at the Instrumentation Labs of M.I.T. under the direction of Dr. C. S. Draper." Pre-production quantities available.—*Greenleaf Mfg. Co., 7814 Maplewood Industrial Court, St. Louis, Mo.*

For more information circle **396** on inquiry card.

Rate Gyro

New "Model 36128" high-performance small-size rate gyro for aircraft and missile control, or telemetering,



is fluid-damped. Thermostat-controlled heating elements keep damping ratio constant over a wide ambient-tempera-

ture range. Fluid-filled case contributes additional protection to shock overload feature.—*G. M. Giannini & Co., Pasadena, Calif.*

For more information circle **397** on inquiry card.

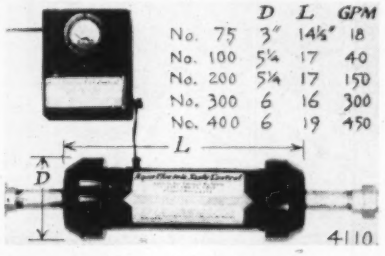
Level-control Electrode

New "WCC" high-pressure liquid-level control electrode will withstand pressures up to 4000 psi. and temperatures up to 800 C. All metal parts are made of non-magnetic stainless steel. Because aluminum oxide insulator (of better than 95 percent purity) has 200,000-psi. compressive strength, new electrodes are expected to replace mica-insulated electrodes now in use. They are equipped with connecting nuts for attaching probes of any desired length or shape; choice of shell threads, etc.—*Auburn Spark Plug Co., Auburn, N. Y.*

For more information circle **398** on inquiry card.

Scale-control Units

New improvements have been incorporated in all five sizes of maker's units for treating water electrically

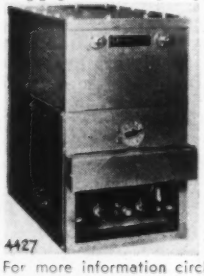


for prevention of hard scale formation. Changes in control box improve operating efficiency; more positive method of applying electrical treatment in cylinder; number of required connections reduced from 4 to 2.—*Aqua Electric Scale Control, Inc., 2028 E. 22nd St., Cleveland 15, Ohio.*

For more information circle **399** on inquiry card.

Automatic Air Drier

New mechanically-refrigerated air drier is unique: it produces a constant supply of clean, dry air to —110 dewpoint; requires no attention; capacities from 4 cfm. up; ready to operate after connections are made to electrical outlet and air supply line.—*Murphy & Miller, Inc., 1326 S. Michigan Ave., Chicago, Ill.*



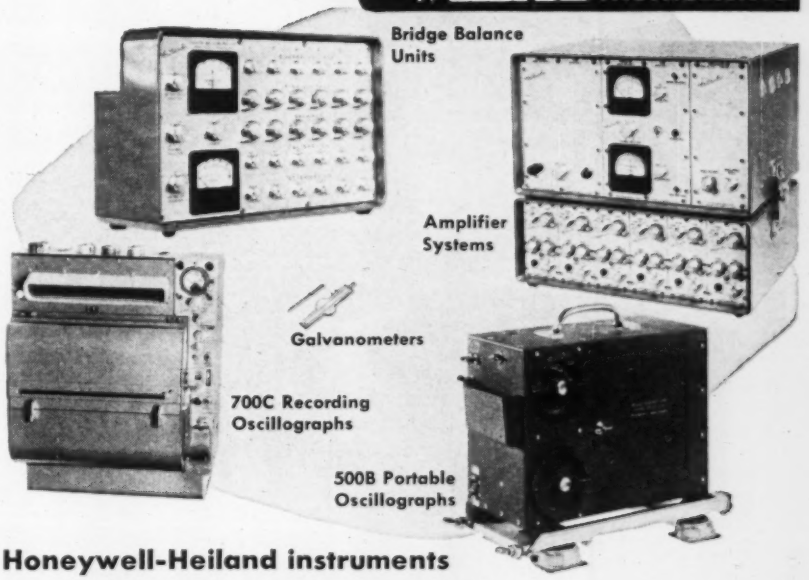
For more information circle **400** on inquiry card.

Demagnetizer

New "Model 889 Magnetreater" quickly and accurately treats most types of electrical instrument magnets, including new core type mechanisms. Its prime function is to effectively de-magnetize saturated magnets to any desired level. Built-in

MINNEAPOLIS Honeywell

Heiland INSTRUMENTS



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Philadelphia 32, Pennsylvania · 3345 W. Hunting Park Ave.
St. Louis 8, Missouri · 4354 Olive Street
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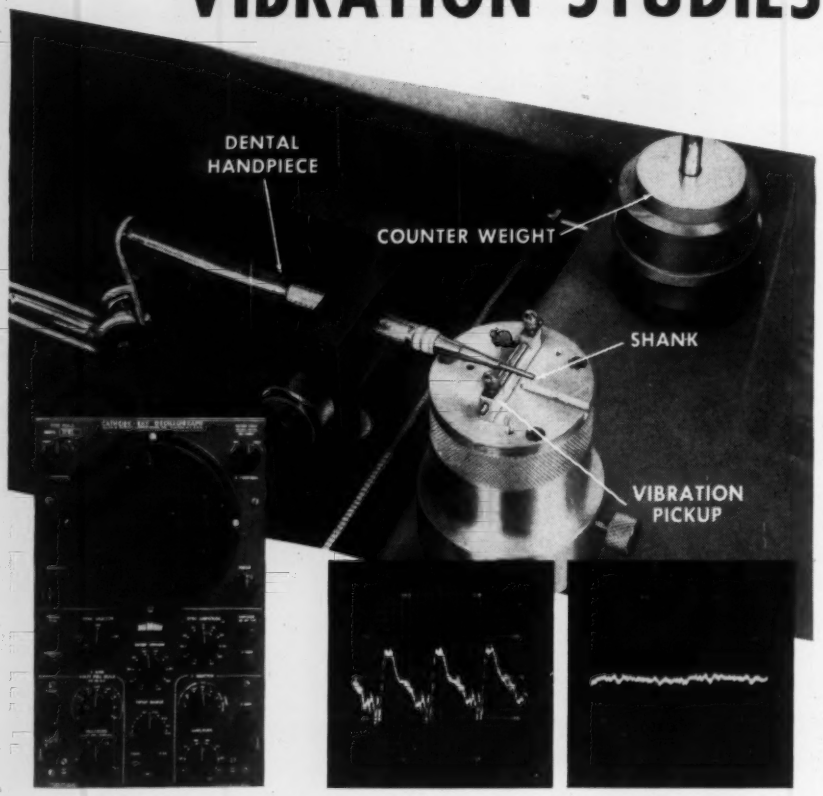
For more information circle **96** on inquiry card.

Applications of cathode-ray oscillography

VIBRATION STUDIES



TYPE 304A ORIGINAL BEARING NEW BEARING

The Physical Setup: A dental handpiece driven by a variable speed motor.

The Problem: To determine the effectiveness of a new bearing design in eliminating vibration from dental handpieces at high speeds.

The Solution: A piezoelectric-type vibration pickup is placed in contact with the side of a smooth shank similar to the shank of a dental burr which is locked in the handpiece under test. The handpiece itself is rigidly fixed in a vertical holder and is driven by a motor, the speed of which can be varied from zero to 10,000 rpm. The motor is mounted on sponge rubber to prevent transfer of vibrations through the table to the vibration pickup, giving a spurious reading. Thus, only vibrations from the handpiece bearings excite the vibration pickup.

The pickup rests on a sensitive lever balance so that various loads can be applied to the shank to simulate actual conditions of service. The output of the vibration pickup is applied to the vertical amplifier of a cathode-ray oscillograph* and the waveform, whose amplitude is proportional to amplitude of vibration, is recorded by an oscillograph-record camera**. The left-hand waveform shows a typical recording of vibration taken from a handpiece with the old style of bearing. The right-hand waveform shows the vibration in the redesigned bearing, taken at the same load and at the same speed of 4000 rpm. With the aid of the cathode-ray oscillograph, bearing design was greatly improved, helping to eliminate pain and tooth damage in patients and increasing the life of dental burrs.

An important application of Du Mont cathode-ray oscillography by the Kerr Manufacturing Company, Detroit, Michigan.

*Du Mont Type 304A
**Du Mont Type 296

A complete compilation of transducers is available from Du Mont for $3.00.

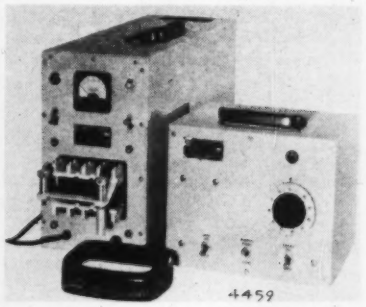
For further information concerning the Du Mont instruments used in this application, contact:

Technical Sales Department
ALLEN B. DU MONT LABORATORIES, INC.
760 Bloomfield Avenue, Clifton, New Jersey

DU MONT *for Oscillography*

For more information circle **97** on inquiry card.

NEW INSTRUMENTS



"Variac" provides a constant discharge rate of approx. 80 pulses per minute.—*Radio Frequency Labs., Inc., 14 Powerville Rd., Boonton, N. J.*

For more information circle **401** on inquiry card.

Electronics Kit

New "Basic Electronics Kit," said to be the first of its kind on the mar-

ket, permits electronics to be taught by "visual experiment."—*Crow Electri-Craft Corp., 1102 Shelby St., Vincennes, Indiana.*

For more information circle **402** on inquiry card.

POWER SUPPLIES

Regulated D-c. Supply

New "Type 807" features wider than usual output range: B supply 0 to +600 v., 0-200 ma.; C supply from 0 to –250 v., 0-5 ma.; additional fixed voltage of –250 v., 0-50 ma. derived from C supply; and unregulated 6.3-v. 10-amp. center-tapped filament supply. It will provide klystrons with up to –600 v. cathode voltage and an additional 0 to –250 v. for reflector. Higher voltages can be obtained through stacking units.—*Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.*

For more information circle **403** on inquiry card.

300-ma. D-c. Supply

New "Model 323" is said to be an unusually compact 200-325-v. 300-ma. regulated d-c. power supply. Panel height 8¾ in.; depth behind panel 9¼ in. Stability is better than 0.1 percent for line or load variations, ripple less than 1.0 millivolt, transient response less than 150 usec.—*Power Designs Inc., 119-22 Atlantic Ave., Richmond Hill 19, N. Y.*

For more information circle **404** on inquiry card.

Regulated Current and Voltage Supply

New "PS-171," developed for use in high-accuracy transistor measurements, has regulated output current of 1 amp. maximum; maintains high output impedance (when used as a constant current supply) or low impedance (when used as a constant voltage supply). This holds true even when a programming or sinoidal signal whose frequency is as high as several hundred cycles is superposed on d.c.—*Scientific Specialties Corp., Snow & Union Sts., Boston* 35, *Mass.*

For more information circle **405** on inquiry card.

H-v. Supply

New "Model 400BDA" has range of 500 to 5100 v. at 0 to 1 ma. Polarity of output is instantly reversible with respect to chassis. Regulation better than 0.01 percent from no-load to full-load and better than 0.01 percent for line voltage changes from 105 to 130. Output is absolutely noise-free; no trace of corona, jitter, or bounce.—*John Fluke Mfg. Co., Inc.*, 1111 *W. Nickerson St., Seattle* 99, *Wash.*

For more information circle **406** on inquiry card.

Regulated Supplies

New line of "B" supplies is said to be the largest and most diversified; includes 32 models each of "Standard" and "Laboratory" grades. Dual supplies, with special built-in switching, cover a wide range of requirements, from 100 v. 100 ma. to 1200 v. 1200 ma. Four modes of operation: separate supplies, parallel, series bucking, and series aiding.—*New Jersey Electronics Corp.*, 345 *Carnegie Ave., Kenilworth, N. J.*

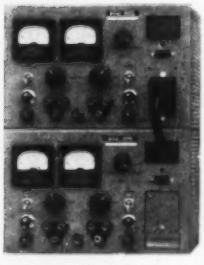
For more information circle **407** on inquiry card.

Supply and Demodulator

New "Model 107 Instrument Power Supply and Demodulator" is an integrated flight test accessory which supplies regulated 400-cps. power for flight instruments, and demodulates 400-cps. outputs from synchro type pickups to allow recording on conventional magnetic oscillographs. Equipment has been designed and packaged in "block" form. Over-all accuracy 1 percent or better. Continuously-variable attenuator's range 100 to 1.—*Dynalysis Development Labs.*, 11941 *Wilshire Blvd., Los Angeles* 25, *Calif.*

For more information circle **408** on inquiry card.

"Combinable" Supplies



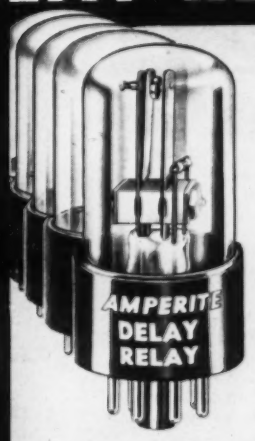
New "Models 1100 and 1101" can be used singly or interconnected (by built-in cables and connectors) to provide extended voltage or current output. Singly, a unit will provide 0 to 250 v. from 0 to 100 ma., regulated over entire range; when stacked and connected in series, group output voltage can be continuously varied from zero volts to sum of outputs. A panel switch selects unit, series, or parallel operation.—*RS Electronics Corp.*, 435 *Portage Ave., Palo Alto, Calif.*

For more information circle **409** on inquiry card.

THERMOSTATIC
DELAY RELAYS

Provide delays ranging from 2 to 150 SECONDS

A M P E R I T E



STANDARD

MOST COMPACT
MOST ECONOMICAL
HERMETICALLY SEALED

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only*—normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to + 70°C. Heaters consume approximately 2 W. and may be operated continuously.

The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive! TYPES:* Standard Radio Octal, and 9-Pin Miniature.

MINIATURE

PROBLEM? Send for Bulletin No. TR-81

Also—a new line of **Amperite Differential Relays** — may be used for *automatic overload, over-voltage, under-voltage or under-current protection.*

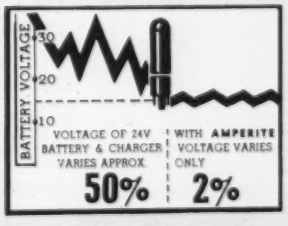
AMPERITE

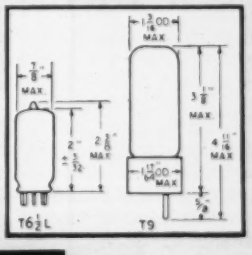
BALLAST REGULATORS

T9 BULB

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., or Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.





AMPERITE CO., Inc.
561 Broadway, New York 12, N. Y.
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Write for 4-page Technical Bulletin No. AB-51

For more information circle **98** on inquiry card.

Test Your I. Q. (Instrument Quotient)

See Page 833 for Answers

All Questions are based on editorial matter in this issue.

Question 1

A punched card is the first step in much of electronic data processing. The number of columns in the IBM punched card is

(a) 60
(b) 80
(c) 90
(d) 100

Question 2

Verification of the punched card is essential for accuracy in electronic data processing. Which of the following statements about verification is NOT true?

(a) Punch machines all perform automatic verification.
(b) An operator must punch the verifier keyboard.
(c) Discrepancies may be indicated by a notch.
(d) The Document-Originating Machine has automatic verification of its reproducing operation.

Question 3

A data processing machine that can perform sorting is

(a) the sorter
(b) the 101 statistical machine
(c) the collator
(d) all the above

Question 4

Lags in a control circuit element are usually defined by a constant equal to the product of the effective resistance and capacity of the element. Which of the following statements about such lags, and their effect on the equation representing a controller circuit, is true?

(a) The lag constant often is called a time constant.
(b) Units of the constant are units of time.
(c) Each lag raises the order of the equation by one.
(d) All the above is true.

Question 5

A three-dimensional psychrometric chart is a plot of

(a) temperature vs. pressure vs. moisture content
(b) temperature vs. dew point vs. moisture content
(c) pressure vs. dew point vs. moisture content
(d) load vs. dew point

Question 6

Which of the following statements about choice of instrument-air dryers is true?

(a) a combination of separator, precooling, and desiccant techniques is often the most economic
(b) load factors affect the cost
(c) a dew point below the lowest temperature to which the air lines will be subjected is neeessary
(d) all the above is true.

Question 7

8-inch and 10-inch floats are commonly used in level controllers to operate a valve stem or a pilot relay. Advantage of using the 10-inch float is

(a) 60 to 70 percent more operating power
(b) 180 to 200 percent more operating power
(c) ability to use with pilot
(d) simpler installation

Question 8

Which of the following statements about displacement-type level controllers is NOT true?

(a) Displacement controllers are more sensitive than float-type controllers
(b) Buoyancy forces on displacement element are opposed by twisting strain of a torque tube.
(c) Torque tube requires only one stuffing box.
(d) Output of torque tube operates a pilot

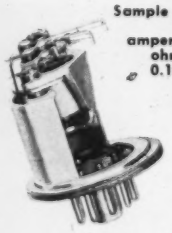
VHS* RELAY

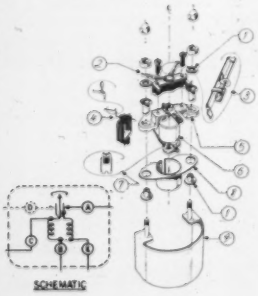
(*Very High Sensitivity)

● The VHS is a balanced armature, Alnico magnet type relay. It is internally shock-mounted and resistant to vibration. The screw-on cover is gasket sealed. It can be opened and resealed.
Connections: 9 pin octal style. Dimensions: 1¾ diameter x 2¼ long. Weight: 4 ounces.
Sensitivity: Infinite variations from 0.2 Ua. to 10 Amp. or 0.1 My. to 500 volts, self contained. Higher volts or amps with external multipliers. A.C. rectifier types. Trip point accuracies to 1%. Differential 1%. The degree of resistance to shock and vibration primarily depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 3-4 G's. The most sensitive relays may close their contacts under these conditions. Contacts: SPST or SPDT, 5-25 Ma. D.C. Other ratings to ½ Amp. A.C. A locking coil gives high pressure and chatter free contact even under shock and vibration. Prices on the order of $20-$80. Delivery 4 to 6 weeks. Assembly Products, Inc., Chesterland 10, Ohio.

Model 266

Sample specs. are: 0.2 micro-amperes, (12,000 ohms coil) or, 0.1 millivolts, (5 ohms.)





1. Shock mount
2. Contact assembly
3. Contact detail
4. Armature with contact detail
5. Cast bracket
6. Alnico magnet
7. Bearing detail
8. Yoke (steel)
9. Mounting frame

For more information circle **99** on inquiry card.

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UP TO 12"

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OVAL WHEEL METER
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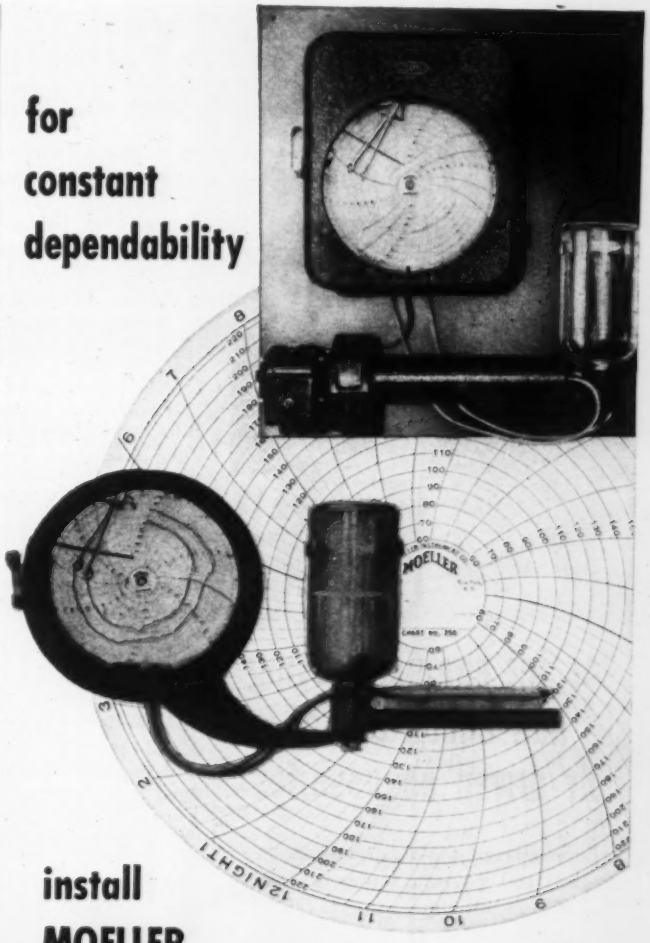

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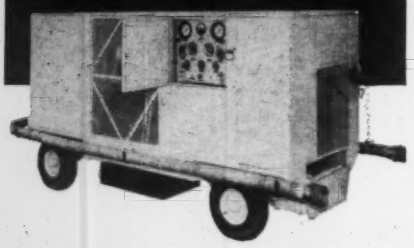

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Events . . .

INSTRUMENTS and AUTOMATION

May 23-25
Ninth Annual Convention of American Society for Quality Control, Hotel Statler, New York City. For information write Ellis R. Ott, Rutgers University, New Brunswick, New Jersey.

May 23-27
Third Annual Conference on Mass Spectrometry, sponsored by the ASTM Committee E-14 will be held at the Mark Hopkins Hotel, San Francisco, Calif. For information write J. G. Hutton, General Electric Co., 1 River Rd., Schenectady, N. Y.

June 6—July 2
Computation Laboratory of Wayne University, four summer courses: (1) Electronic Computers, business and engineering applications; (2) Automatic Data Processing; (3) Mathematical Programming of management problems; (4) Numerical Methods and Advanced Programming Techniques. Write to A. W. Jacobson, Dir., Computation Laboratory, Wayne Univ., Detroit 1, Mich.

June 6-10
Third Human Engineering Institute will be held at Dunlap & Associates, Inc., 429 Atlantic St., Stamford, Conn. For information contact M. A. Tolcott, c/o Dunlap & Associates.

June 9-10
Conference on Carbon will be held at University of Buffalo, Buffalo, N. Y. For information write Carbon Conference, Department of Physics, University of Buffalo, Buffalo, New York.

June 13-17
Annual Symposium on Molecular Structure and Spectroscopy, Ohio State University. For information write Prof. Harold H. Neilsen, Dept. of Physics, Ohio State University, Columbus 10, Ohio.

June 14-16
First Magnetics Conference and Exhibit sponsored by the Basic Science Committee of the American Institute of Electrical Engineers in cooperation with the American Physical Society and the American Institute of Mining and Metallurgical Engineers, William Penn Hotel, Pittsburgh, Pa. For information write A. C. Beiler, C/O Westinghouse Electric Corp., 2-F Materials Engineering Department, East Pittsburgh, Pa.

June 16-18
Committee On Vacuum Techniques of Boston, Massachusetts, High Vacuum Symposium will be held at Berkeley Carteret Hotel, Asbury Park, N. J. For information write the Committee, Box 1282, Boston 9, Mass.

June 16-19
Conference: "The Automatic Factory —What does it mean?" at Margate, England. For information write to Institution of Production Engineers, 10, Chesterfield St., London W.1. England.

June 27-29
First Annual Meeting of the American Nuclear Society, at Pennsylvania State University, "will be representative of all major interests in peacetime atomic energy." Write to Prof. W. W. Miller, Pennsylvania State University, State College, Pa.

June 28-July 9
Third British Instrument Industries' Exposition at Earl's Court, London. For information write F. W. Bridges & Sons, Ltd., Grand Bldg., Trafalgar Square, London W. C. 2, England.

July 10-23
Technical Association of the Pulp and Paper Industry Conference on Statistics in the Paper Industry, Forest Products Laboratory, Madison, Wis. For information write Fred R. Sheldon, Becco Chemical Div., Food Machinery Corp., Buffalo 7, N.Y.

July 20-22
The Instituto Tecnologico y de Estudios Superiores de Monterrey, announces the first Annual Short Course on Instrumentation for Industry, Monterrey, N.L. Mexico. For information write Ing. Carlos Lopez Garcia, Depar tamento de Ingenieria Quimica.

August 1-12
University of Michigan Summer Session on "Digital Computers and Data Processors—A Report from the Users." For information write John W. Carr, Digital Computation Dept., Willow Run Research Center, University of Michigan, Ypsilanti, Mich.

August 17-19
"The Computing Laboratory in the University", University of Wisconsin, Madison, Wis. For information write Preston C. Hammer, Numerical Analysis Laboratory, University of Wisconsin.

August 22-23
"Electronics and Automatic Production" Symposium, sponsored by Stanford Research Institute and National Industrial Conference Board, at San Francisco. For information, write to the Institute at Palo Alto, Calif.; or to the NICB, 247 Park Ave., New York, N.Y.

August 22-Sept. 2
Summer Program in "Numerical Control of Machine Tools" will be held at Massachusetts Institute of Technology. For information write Summer Session Office, Rm. 7-103, M.I.T., Cambridge 39, Mass.

August 24-Sept. 3
12th Annual British National Radio Show will be held at Earls Court, London, England. For information write Andrew Reid, 11, Garrick St., London WC. 2, England.

August 24-26
1955 IRE Western Electronics Show and Convention, Civic Auditorium, San Francisco, Calif. For informa-

tion write W. A. Edson, Applied Electronics Laboratory, Stanford, Calif.

September 12-16
Tenth Annual Conference and Exhibit of the Instrument Society of America will be held at Shrine Exposition Hall and Auditorium, Los Angeles, Calif. For information write Fred J. Tabery, 3443 South Hill St., Los Angeles 7, Calif.

September 14-16
Annual General Meeting of the Association for Computing Machinery, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. For information write Sidney Kaplan, R.C.A. Computing Systems Engineering, Building 13-2, Camden 2, N. J.

September 28-30
Sixth TAPPI Testing Conference, Sheraton-Kimball Hotel, Springfield, Mass. For information write Wm. Schoenberg, 1878 East 18th St., Cleveland 14, Ohio.

October 3-5
11th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. For information write J. Kocek, c/o Illinois Bell Telephone Co., 208 W. Washington St., Rm 300, Chicago 6, Ill.

October 3-6
25th Annual Meeting of Society of Exploration Geophysicists, Shirley Savoy Hotel, Denver, Colo. For information write Colin Cambell, 624 S. Cheyenne, Tulsa, Oklahoma.

October 5-14
Tenth General Conference on Weights and Measures will be held in Paris and Sevres, France. For information write National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D.C.

October 13-15
Committee on Vacuum Techniques, Inc., will hold their Second Symposium on Vacuum Technology at Mellon Institute, Pittsburgh 13, Penna. For information write Rudy Koehler, Committee on Vacuum Techniques, Inc., Box 1282, Boston 9, Mass.

October 24-25
First Annual Technical Meeting of the Professional Group on Electron Devices of the I.R.E., will be held at The Shoreham Hotel, Washington, D.C.

October 27-28
11th Annual Meeting of National Conference on Industrial Hydraulics, LaSalle Hotel, Chicago, Ill.

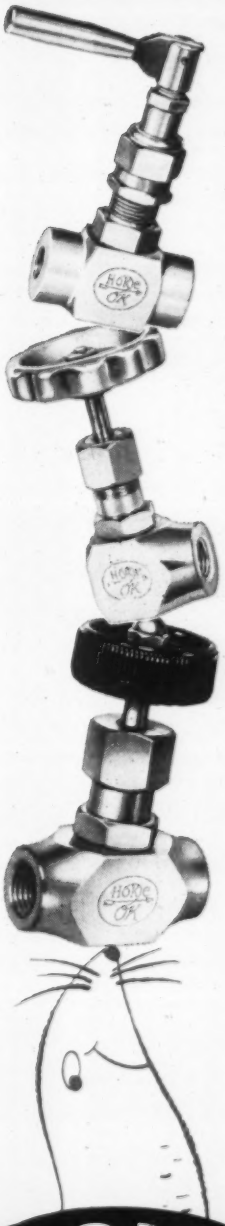
November 3-4
Fourth Annual Louisiana Polytechnic Institute Instruments Conference, Ruston, Louisiana. For information write School of Engineering.

November 14-17
Second International Automation Exposition will be held at Chicago's Navy Pier. For information write The Second International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

HOKE

Flow Sheet

Hoke reports on fluid control



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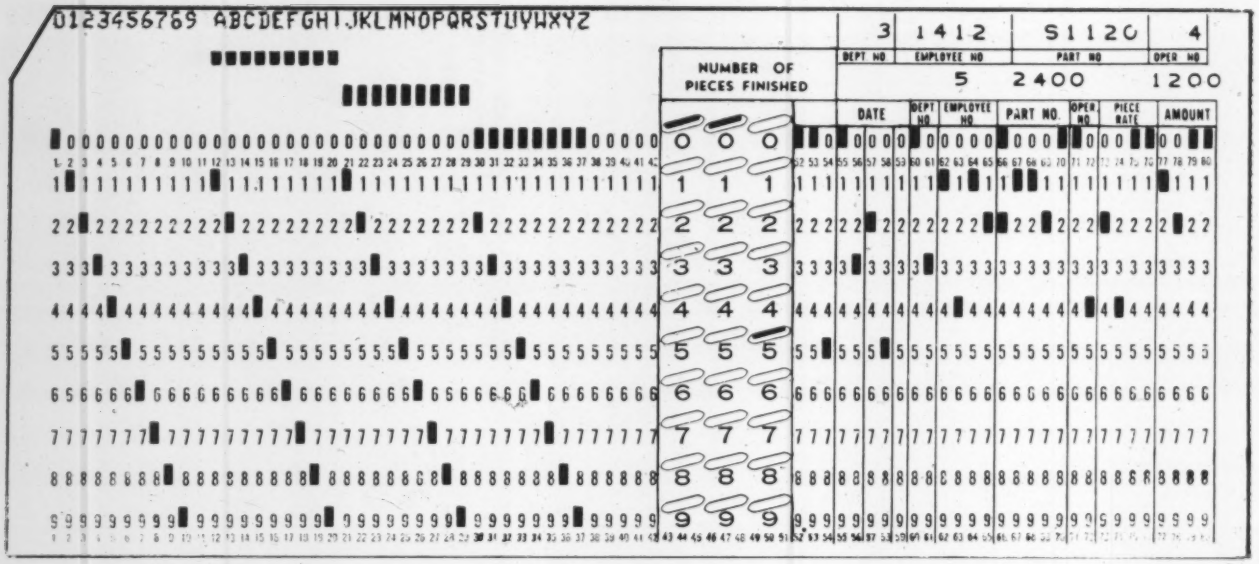

Fig. 1. An IBM punched card, the first step in IBM automatic data processing. The 80 columns are numbered at the bottom.

Electronic data-processing machines have become basic tools for industry, business, finance, and scientific computations. Here is a thorough résumé of an extensive line—punched cards, verification, duplication, tape reading, transceiving, interpreting, sorting, selecting, merging, matching, form feeding, and facsimile posting. Fundamentals of statistical machines, small computers, card-programmed calculators, and large-scale data processing machines are presented.

Electronic Data-processing

PURPOSE of this automation clinic* is to describe the machines already in existence which automatically process a wide variety of information or data.

Many machines have been invented to help with arithmetic and printing, most of which were operated individually by a person pushing levers or keys. With the development of the punched card (around the beginning of this century) the first step in automatic operation of machines for office and engineering data-processing became possible. Once information was punched into a card, two important results were accomplished—(1) a permanent record was available, and (2) the cards could be used to carry information from one machine to another, and to allow automatic control of the machines during the processing of the information.

In just the past few years, with the building of large electronic machines with large storage and data-processing capacity, it has become possible to do much data handling inside one device. These recent advances have been made possible partly because of the development of magnetic tapes which now provide large data-storage capacity as well as rapid means of entering and removing data from a machine. This greatly extends the ability and versatility furnished by punched cards.

*Presented at Computer Clinic, First International Automation Exposition, New York, N. Y., Nov. 29-Dec. 2, 1954.

The Punched Card

The punched card (Fig. 1) is usually the first step in automatic processing of data.

The IBM card has 80 vertical columns (numbered at the bottom). Each column accommodates a hole (or holes) representing a single number or letter. At the left of the card is shown the simple and logical punching system for representing numbers and letters. For example, the letter S is represented by the punches 0 and 2, as shown in column 30 of the sample card (Fig. 1).

Information to be included in the card is determined by the requirements of the final reports and documents. Data to be processed must be punched in the card according to a standard arrangement. Consequently, columns on the card are grouped, and reserved for the recording of each fact required.

An IBM card—once punched and verified—is a permanent record. It then can be read by machines to do transcribing and other processing at high speed. The following is a partial list of what the punched hole in the card will do:

1. It will add itself to something else.
2. It will subtract itself from something else.
3. It will multiply itself by something else.
4. It will divide itself into something else.
5. It will list itself.

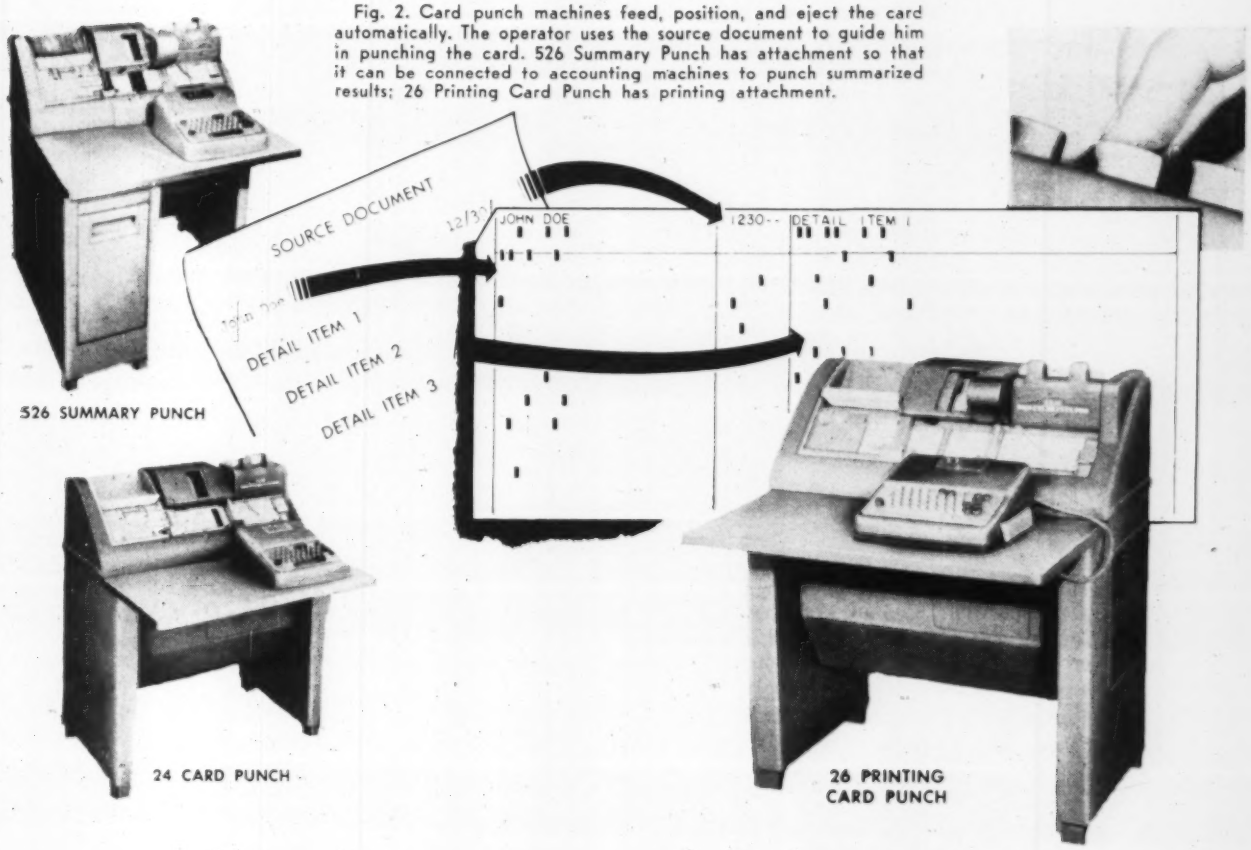

Fig. 2. Card punch machines feed, position, and eject the card automatically. The operator uses the source document to guide him in punching the card. 526 Summary Punch has attachment so that it can be connected to accounting machines to punch summarized results; 26 Printing Card Punch has printing attachment.

Machines

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6. It will reproduce itself.
7. It will classify itself.
8. It will select itself.
9. It will print itself on the IBM card.
10. It will produce an automatic balance forward.
11. It will file itself.
12. It will post itself.
13. It will reproduce and print itself on the end of a card.
14. It will be punched from a pencil mark on the card.
15. It will cause a total to be printed.
16. It will compare itself to something else.
17. It will cause a form to feed to a predetermined position, or to be ejected automatically, or to space from one position to another.

The card may be thought of as a control link in a mechanical system for data processing because that is exactly what the card is when it moves through a machine.

At the right of the card in Fig. 1 is shown a typical application. This card with the information shown can be used in payroll, production costs, inventory, and other applications.

Card Punching

Card punching is the basic method of converting source data into the punched cards. Typical card punches are shown in Fig. 2. The operator reads the source document and, by depressing keys, converts the information into punched holes. The machine feeds, positions, and ejects the card automatically. The operator's primary concern is to depress the proper keys in the correct sequence in order to punch the card properly. Card punches equipped with printing mechanisms automatically interpret the punched information at the top of the card directly above the hole being punched. Almost all of the machines use some electronic equipment.

Verification

Verification of initial data is extremely important. Usually the best time to verify information is immediately after it has been punched into cards. A typical card verifier is shown in Fig. 3.

Card verifying is simply a means of checking the accuracy of the original key punching. A second operator verifies the original punching by depressing the keys of a verifier while reading from the same source data. The machine compares the key depressed with the hole already punched in the card. A difference causes the machine to stop, indicating a discrepancy between the two operations.

A notch in the upper right edge of the card indicates that it has been key punched and verified correctly. A notch directly above a column signifies that the punching of that column is in error.

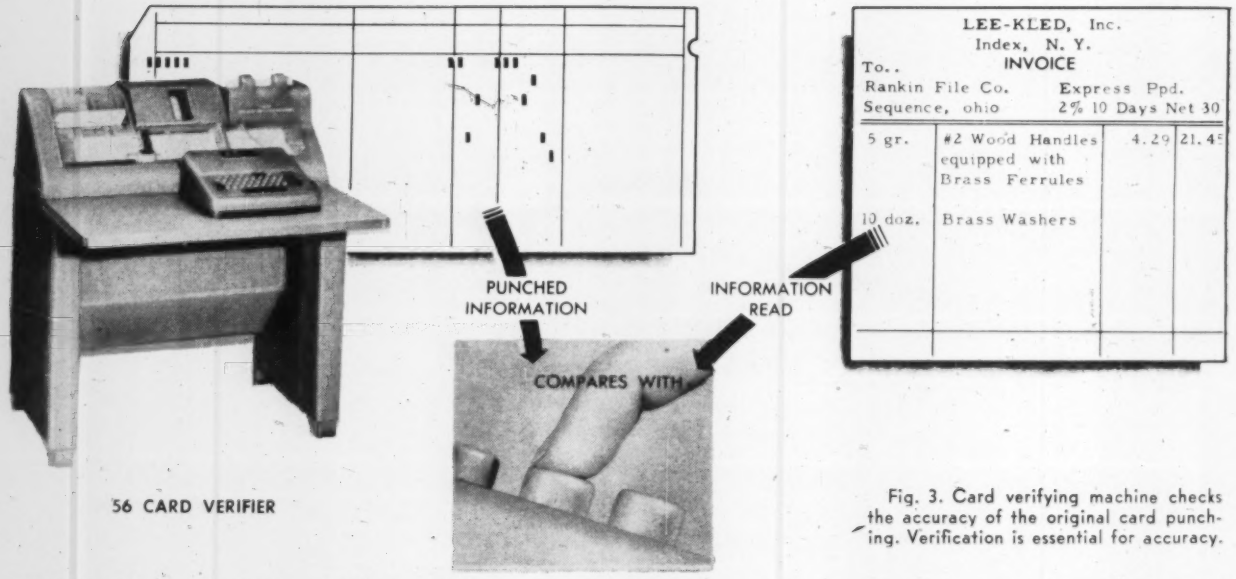


Fig. 3. Card verifying machine checks the accuracy of the original card punching. Verification is essential for accuracy.

Verification becomes increasingly important as faster data-processing machines become available. For example, if you furnish wrong information to a giant computer, it will produce thousands of wrong answers in a second, and the entire blame for this must be charged to lack of verification.

Duplication

The use of the machines to automatically copy information in cards is called duplication (Fig. 4). Duplication is automatic punching of repetitive information from a master card into a group of succeeding detail cards. It is normally performed as part of the card-punching function on the card punches shown in Fig. 2. Instead of depressing keys repetitively for common information (such as ENTRY DATE, which is to be punched in every card), the operator punches the common information only once in the first card group, and it is automatically punched into all remaining cards for the group. Automatic duplication reduces the work per card, insures consistency of common data, and increases productivity of the operator.

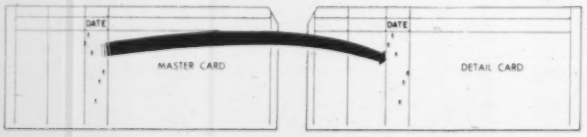


Fig. 4. Duplication is use of machines to automatically copy information in cards—that is, automatic punching of repetitive information from a master card into a group of succeeding cards. Card punches (Fig. 2) can also duplicate. Duplication is but one function of the machines shown in Fig. 2.

Gang punching (Fig. 5) is duplication in which punched information from a master card is copied into one or more detail cards that follow it.

In single master-card gang punching, one master card precedes all detail cards to be punched with the same information.

Where information changes from one group of cards to the next, interspersed gang-punching methods may be used. A master card precedes each group of detail cards. Information in the master card is automatically selected

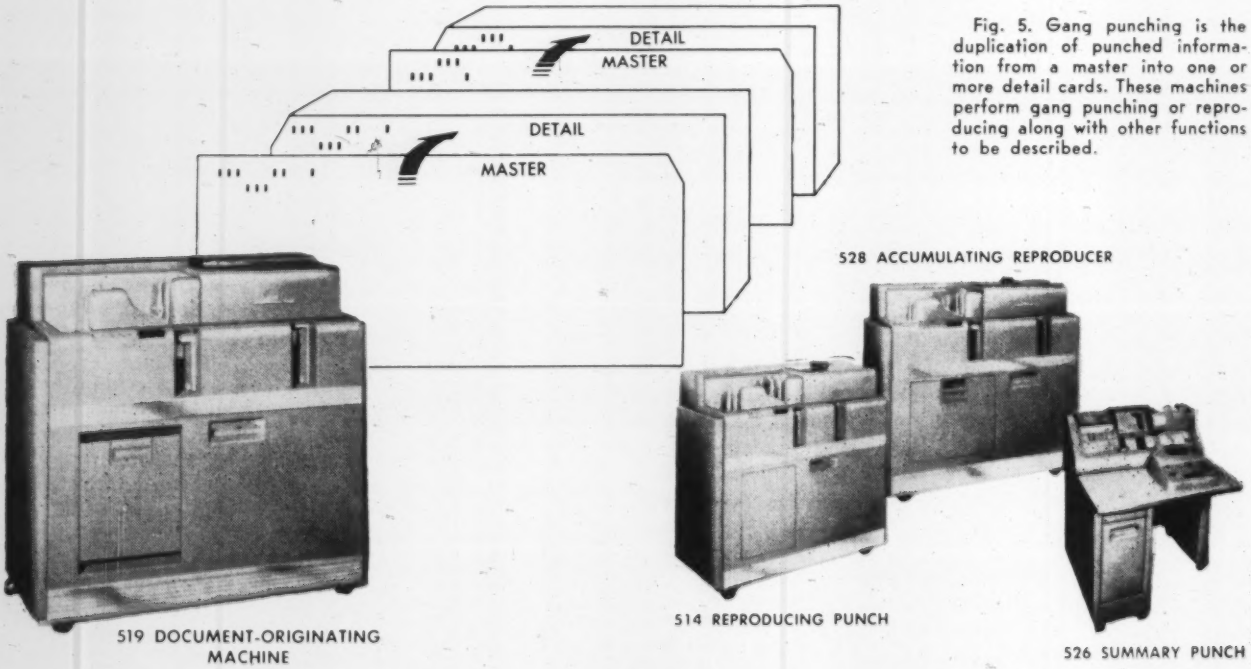


Fig. 5. Gang punching is the duplication of punched information from a master into one or more detail cards. These machines perform gang punching or reproducing along with other functions to be described.

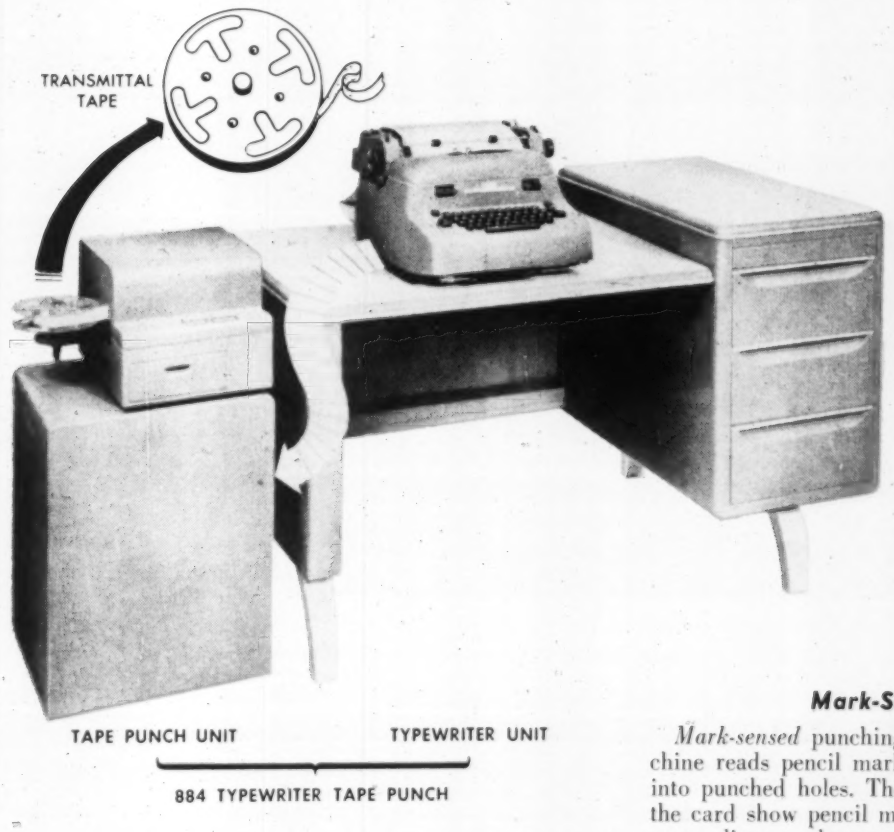


Fig. 6. Electric typewriter and tape punch unit comprise the 884 Typewriter Tape Punch, which puts coded information on 8-channel punched-paper tape. Special electric typewriter connected to Type 24 or 26 card punch (Fig. 2) comprises system for simultaneously typing a document and putting the same information into punched cards.

for punching into all following detail cards until a new master is read. The punching pattern then changes to conform with the new master.

Gang punching can be performed separately or in combination with reproducing and summary punching for both alphabetical and numerical information.

It should be noted here that the cards now contain both data to be copied and information, also in the form of punched holes, for the control of the machine.

Reproducing is a form of duplication in which information from one set of punched source cards is automatically punched into another set of cards. The two sets of cards are fed through the machine synchronously. The machines used for reproducing are those shown in Fig. 5 (except # 526).

For verification of this reproducing operation these machines have a comparing feature which proves agreement between originals and reproductions. Differences are automatically indicated.

Another feature of these and most other IBM machines is their electrical control panel. By interchanging these panels, or by changing a few wires in a single panel the operation of the machine may be very easily and quickly changed from one type of procedure to another. This allows the machines to be used on a variety of problems, thereby extending their usefulness.

There are several additional ways to originate punched cards by automatic methods. It is possible for any of the punches which are shown in Fig. 5 to be connected to any machinery having a digital output of the appropriate form. An excellent example of this is in the connection of IBM punches to a wind tunnel installation in Texas. The equipment associated with the tunnel automatically sends 35,000 pressure readings directly to the IBM equipment. Over one hundred hours of photographing, processing, reading, punching, and verifying are completely eliminated for each run; the efficiency of operating this wind tunnel is greatly increased.

Mark-Sensed Punching

Mark-sensed punching is illustrated in Fig. 1. A machine reads pencil marks on a card and converts these into punched holes. The three columns in the center of the card show pencil marks for the value 005. The corresponding punches are shown in columns 52, 53, and 54, having been punched there by one of the machines in Fig. 5 (except the 526). This type of operation has been proven in many applications during the past 20 years. The original facts may be recorded anywhere—office, plant, or field, by workmen, timekeepers, or field workers—and those facts are translated directly into punched hole form. This type of marking has been used for grading multiple-choice and true-false tests by means of IBM test-scoring machine. One of the most recent new uses of mark-sensed cards was for ballots in the city council election in Richland, Washington.

Ticket Converting

Ticket converting is the process of changing prepunched ticket stubs into IBM cards. A typical application is in merchandising and use of price tickets.

The 549 Ticket Converter Machine performs this ticket conversion.

Typewriter Card and Tape Punching

Typewriter card punching is the simultaneous action of creating a document in a typewriter and putting part or all of the same information into punched cards. This machine consists of a special IBM electric typewriter connected to a Type 24 or 26 card punch.

Typewriter tape punching is the simultaneous action of creating a document in a typewriter and putting part or all of the same information into an 8-channel punched paper tape (Fig. 6). The tape can be easily transported to other locations and processed through a tape-to-card punch (Type 46 or 47) to transfer the information into punched cards.

Either of the above two typewriter and punch combinations can be used to prepare any document now created on a typewriter and at the same time eliminate the need for separate manual card-punching and verifying operations.

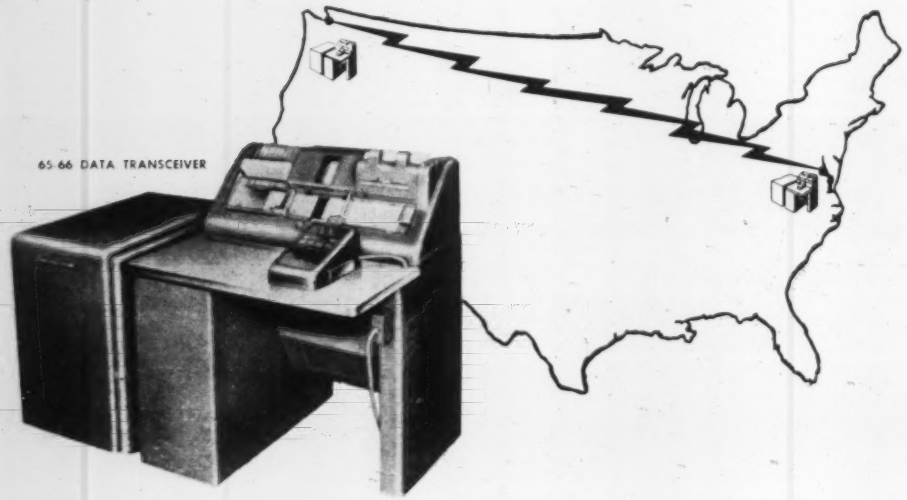


Fig. 7. Data transceiver accepts punched-card data and reproduces card at remote location by telephone or telegraph. Machines at either end are identical.

Typical applications of these machines are for billing, order writing, personnel changes, address changes, insurance policies, railroad accounting, journal vouchers, purchase orders, receiving reports, directories, inventory control, check reconciliation, and many others.

Tape Reading

Tape reading is a process of feeding punched paper tapes through a tape-to-card punch to convert the coded data onto punched cards. Tapes can be prepared on the typewriter tape punch or on the card-controlled tape punch; the latter is capable of punching tape that can be transmitted by telegraph.

Transceiving

Card-to-card transceiving makes possible instantaneous and accurate duplication of punched cards over telephone and telegraph networks between locations separated by thousands of miles (Fig. 7).

Two installations now are in use for transmitting data between engineering locations and their Type 701 computing centers. Decentralization of an organization is now quite possible, along with the maintenance of a data processing center. This equipment has also been used in a radio link between Africa and the United States.

Documents with IBM Data

Documents on which additional information is written or marked are now often found in the form of IBM cards. For example, about one billion cards were used in 1954 in the form of postal money orders, government checks, and miscellaneous company checks. Additional millions of cards were used as public utility bills, gasoline credit cards, merchandise re-order forms, etc.

For these and other applications it is advantageous to have some or all of the punched information written on the card. Printing can be done at the time of punching, as shown in Fig. 2. If it is not done at that time it can be done automatically by other machines (such as the 552 and 557 Alphabetic Interpreters).

Interpreting

Interpreting is the translation of punched holes into printed information on an IBM card.

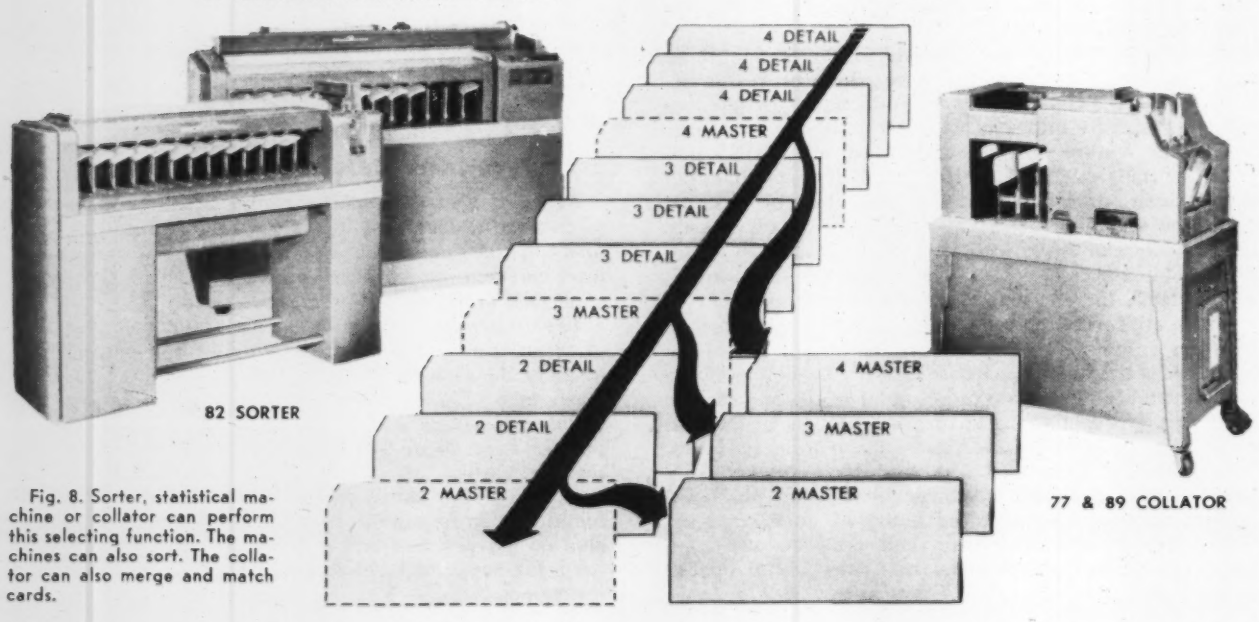


Fig. 8. Sorter, statistical machine or collator can perform this selecting function. The machines can also sort. The collator can also merge and match cards.

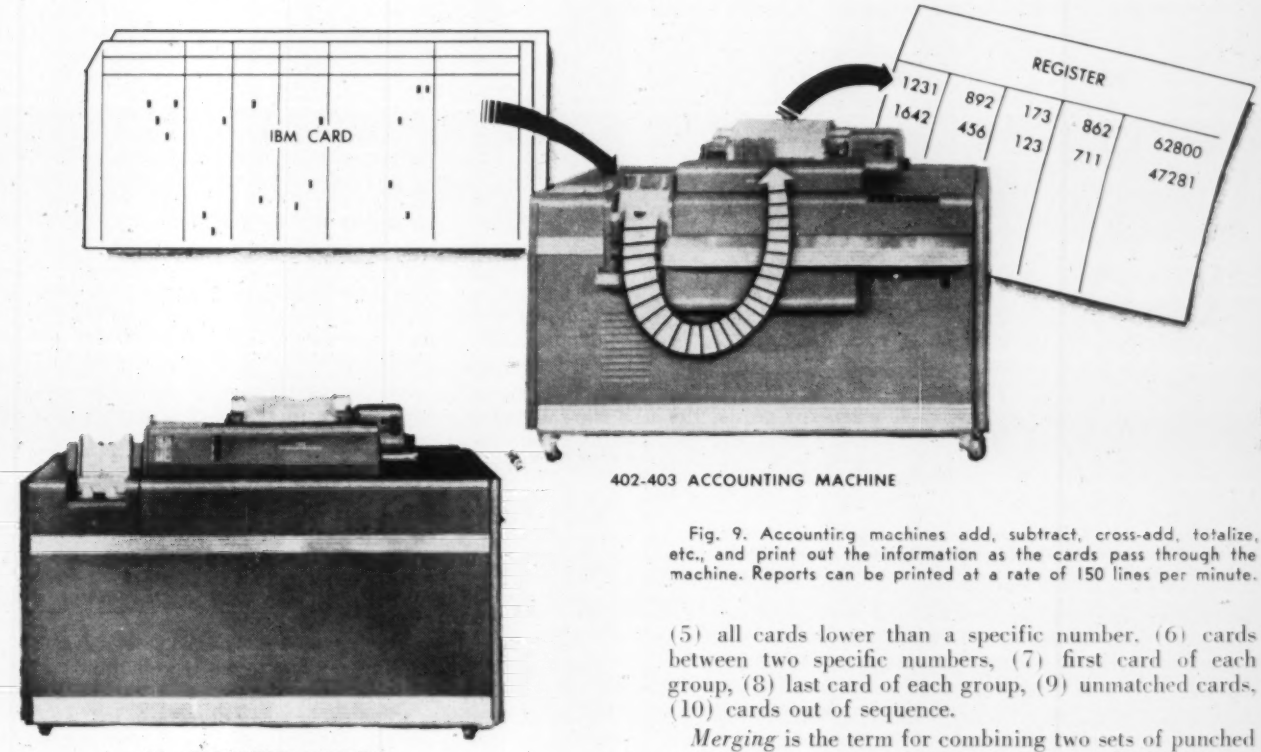


Fig. 9. Accounting machines add, subtract, cross-add, totalize, etc., and print out the information as the cards pass through the machine. Reports can be printed at a rate of 150 lines per minute.

Alphabetic or numerical information can be printed in many different positions on the same card from which it is read. Common data can be repetitively printed on a group of detail cards from punched information on a master card.

End Printing

End printing is the conversion of punched information into bold printing across the end of the card simultaneously with gang punching, summary punching, reproducing, and mark-sensed punching (all functions of the 519 Document-Originating Machine shown in Fig. 5). It is similar to interpreting, and makes possible quick reference to the card.

Sorting, Selecting, Merging, Matching

After cards have been punched it is usually necessary to arrange or rearrange their sequence, select certain cards, or add additional cards before actually processing them for arithmetic operations. This type of data processing can be done automatically by several different machines.

Sorting is the process of grouping cards in numerical or alphabetical sequences according to any classification punched in them. To group cards by account, for instance, they are sorted into account sequence. It is then possible to summarize the cards by account.

Fast, automatic machines (Fig. 8) are provided for arranging cards for the preparation of reports originating from the same cards, but each requiring a different sequence or grouping of information.

Selecting is the function of pulling from a mass of data, certain items that require special attention. Selection of individual cards is accomplished automatically by either the sorter or collator (Fig. 8) according to the type of selection. Typical selections are: (1) cards punched with specific digits, (2) certain type of cards for a specific date, (3) all cards containing a specific number, (4) all cards higher than a specific number, (5) all cards lower than a specific number, (6) cards between two specific numbers, (7) first card of each group, (8) last card of each group, (9) unmatched cards, (10) cards out of sequence.

Merging is the term for combining two sets of punched cards into one set of given sequence. Both files of cards must be in the same sequence before they are merged. This function makes possible automatic filing of the new cards into an existing file of cards. It is a faster method than sorting for placing related cards together. Merging is performed automatically in a collator.

Matching is the term for a checking function used to check the agreement between two sets of cards. Groups of cards in one file are compared with similar groups in a second file. Unmatched cards or groups of cards in either file may be selected or separated from the files. This function is frequently performed in conjunction with merging in the collator (Fig. 8).

An application of matching would be that of accounts receivable where cards for each outstanding bill are matched against payments. The unmatched cards represent accounts still unpaid.

As a collator has two card feeds and four selecting pockets, the functions of merging, matching, sequence checking, and selecting may be formed in many different combinations. After the cards are properly arranged they are ready for processing by a variety of machines.

Detail and Group Printing by Accounting Machines

Detail printing is the printing of information from each card as the card passes through the machine. The function is used to prepare reports that show complete detail about each transaction. During this listing operation the machine adds, subtracts, cross-adds or cross-subtracts and prints many combinations of totals. These operations are performed by the machines in Fig. 9.

The accounting machines, thousands of which are in daily use, can print reports at the rate of 150 lines per minute. The Type 407 accounting machine has many outstanding features, among which is the ability to check the printing of a number and its sign.

Group printing is an accounting-machine function that summarizes groups of cards and prints the totals on a report. Totals may involve adding, subtracting, etc.

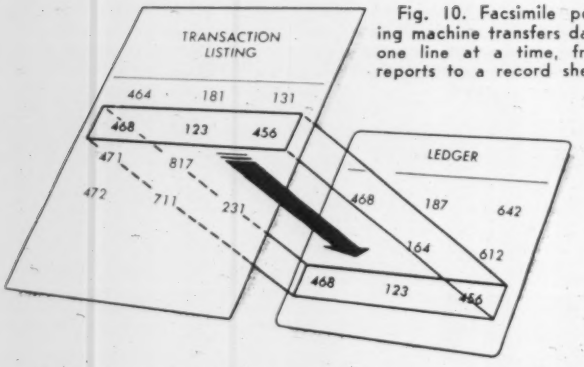


Fig. 10. Facsimile posting machine transfers data, one line at a time, from reports to a record sheet.

Information read from punched cards is entered into counter units: at the end of each group of cards, the totals are read out of the counters and printed on the report. This function is used in preparing reports requiring summarized totals. Complete descriptive information identifies all totals.

Form Feeding

Form feeding is the rapid, accurate positioning of reports and documents on which accounting-machine results are printed. The tape-controlled automatic carriage feeds continuous paper forms (single or multiple copies) such as registers, reports, and paper checks. A *bill feed* positions single forms, such as ledger sheets, envelopes, or IBM cards. A *dual-feed carriage* feeds two different forms simultaneously, for printing some or all of the same accounting-machine results from the same type bars but with different spacing. All of the devices control feeding within each form, to specific lines if required, as well as form-to-form ejection. A variety of document printing arrangements are available for mounting on, and use with, the accounting machines in Fig. 9.

Summary Punching

Summary punching is the term for automatic conversion into punched-hole form of information developed by the accounting machine. Summary punching is used for the following purposes:

1. To carry balance figures forward. To do this, it is only necessary to include the previous total-to-date card with the current card or cards, and, while a current report is being run, summary punch new balance-to-date cards. These are saved for the next balance-to-date operation when the process is repeated. The counterpart of this operation in scientific computing applications would be that of punching intermediate results for use in future calculation procedures.

2. To reduce card volume and carry summary data. Summary cards reduce peak-load periods due to accumulated card volume, and can be used as entries to general ledger accounting.

Summary data also can be fed, by cable, to the Summary Punch Machine shown in Fig. 2. Summary punching also can be performed by the 519 Document-Originating Machine shown in Fig. 5.

All of the accounting machines described have features which give them great interchangeability of application. It takes only a few seconds to change the machine from one type of operation to another.

Facsimile Posting

It often is desirable to transfer information from reports to a ledger or other record sheet. This may be done by Facsimile Posting Machine. One line at a time is transferred by a duplicating process. (Fig. 10).

Typical uses of this function are the posting of customer ledgers, employees earning records, and stock ledger cards.

Statistical Machines

Many problems in statistics are handled well by the statistical machine shown in Fig. 11.

Statistical work is essentially a problem of counting units in many different classifications. At the same time it is frequently desirable to accumulate certain quantities or amounts, check or edit for consistency or reasonableness, and balance counts to the control totals to check the accuracy of the summaries. All of these functions are performed by the Electronic Statistical Machine to produce printed summaries. This machine also performs sorting and card-arranging operations.

The first large-scale use of these machines was for processing a great deal of the United States 1950 census data. Since that time they have been used in census operations in many other countries. They are also used in searching card files of books or reference articles, chemical and physical characteristics of substances, police records, and other applications.

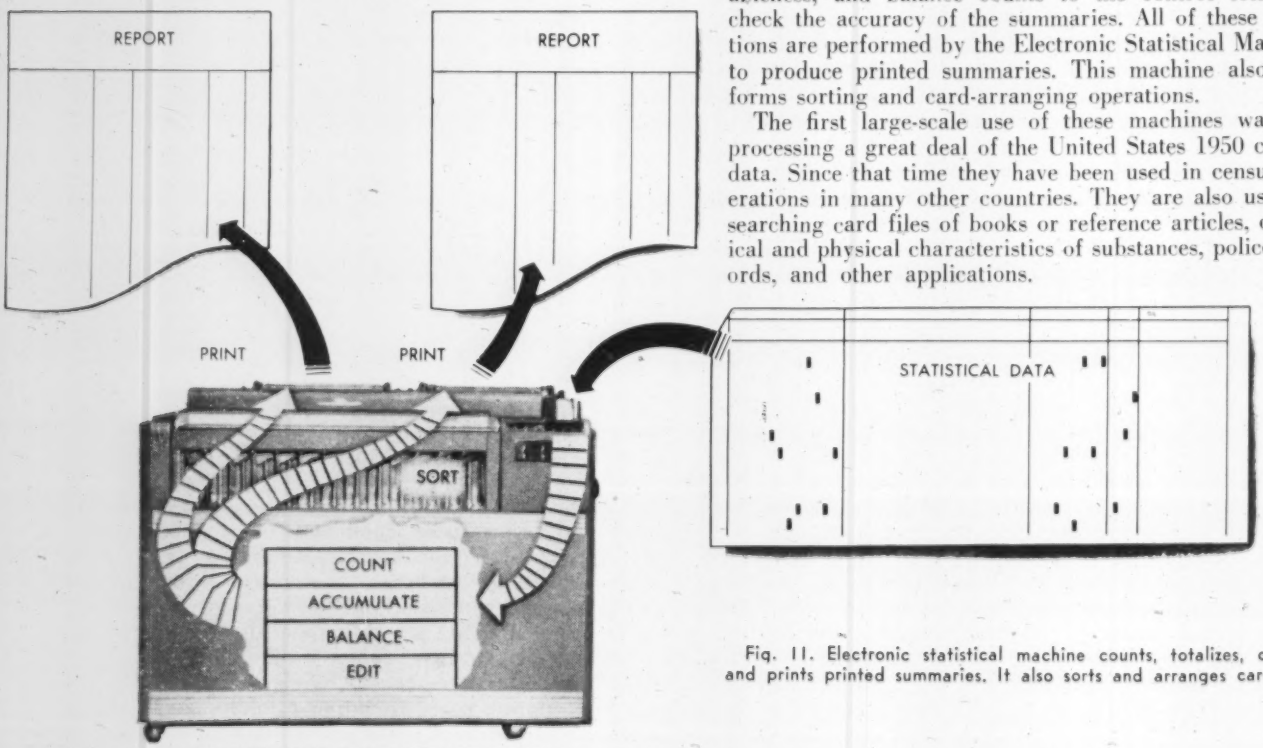
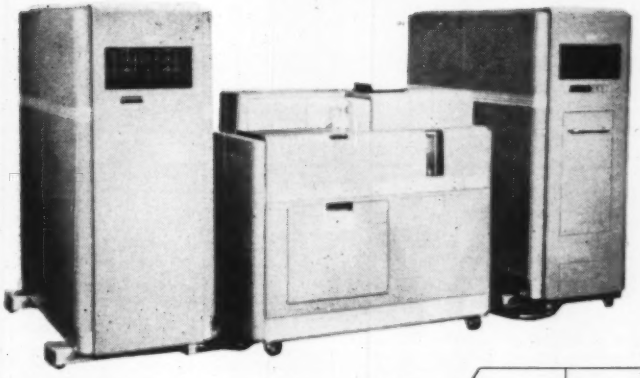
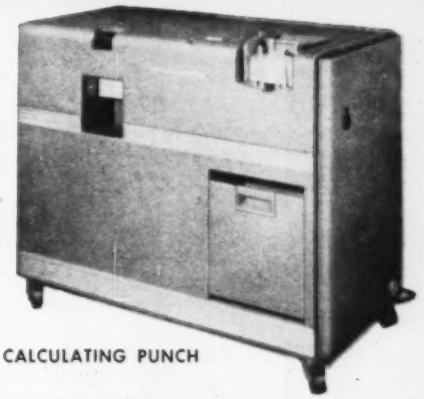


Fig. 11. Electronic statistical machine counts, totalizes, checks, and prints printed summaries. It also sorts and arranges cards.

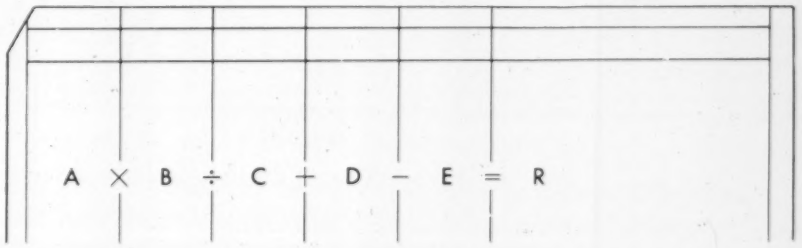


607 ELECTRONIC CALCULATING PUNCH
(604 IS SIMILAR)



602A CALCULATING PUNCH

Fig. 12. Typical small automatic digital calculators.



Small Digital Calculators

During the 1940's there arose an increasing demand for machines which could do more complicated arithmetic for accounting problems. Even payroll calculations, which are usually thought of as being simple, sometimes require many steps of arithmetic to calculate gross pay, many deductions, net pay, and new year to date values. Also during those years more interest was shown for the use of automatic calculating machines in the fields of scientific computation. The result of the interest shown in these two fields led to the large-scale production of electromechanical and electronic calculators. Typical examples of these machines are shown in Fig. 12.

The widespread acceptance of these machines is indicated by the fact that from 1948 through 1954 more than 2000 IBM Type 604 electronic calculating punches were installed in business offices in the United States. Each of these machines contains over 1300 electronic tubes. Each machine reads and punches cards at the rate of 100 cards per minute, and for each card up to 60 individual steps of arithmetic may be performed. Typical business applications of these small electronic calculators include: Payroll calculations, interest calculations, insurance premium calculations, discounts, invoice calculations, agents and brokers discounts and commissions, and actuarial tables.

These calculators are used also to solve scientific and engineering calculations such as: formula evaluation, numerical differentiation and integration, solution of simultaneous equations, curve fitting, solution of differential equations, correlation and regression analysis, and matrix manipulations.

A slightly larger and much more capable computer than those previously described is the Card-Programmed Calculator (Fig. 13).

Card-Programmed Calculator

The CPC is actually composed of several machines which are connected together by electrical cables. The Accounting Machine reads from the punched cards the data to be calculated and the codes that instruct the machines what calculation to perform. The data may be

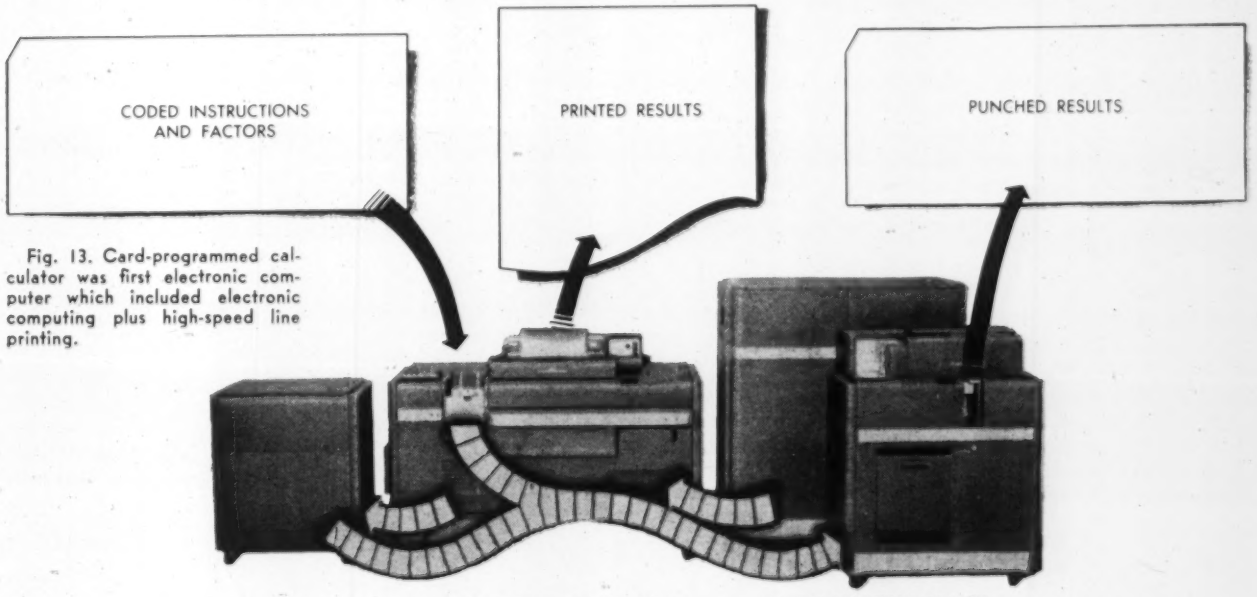
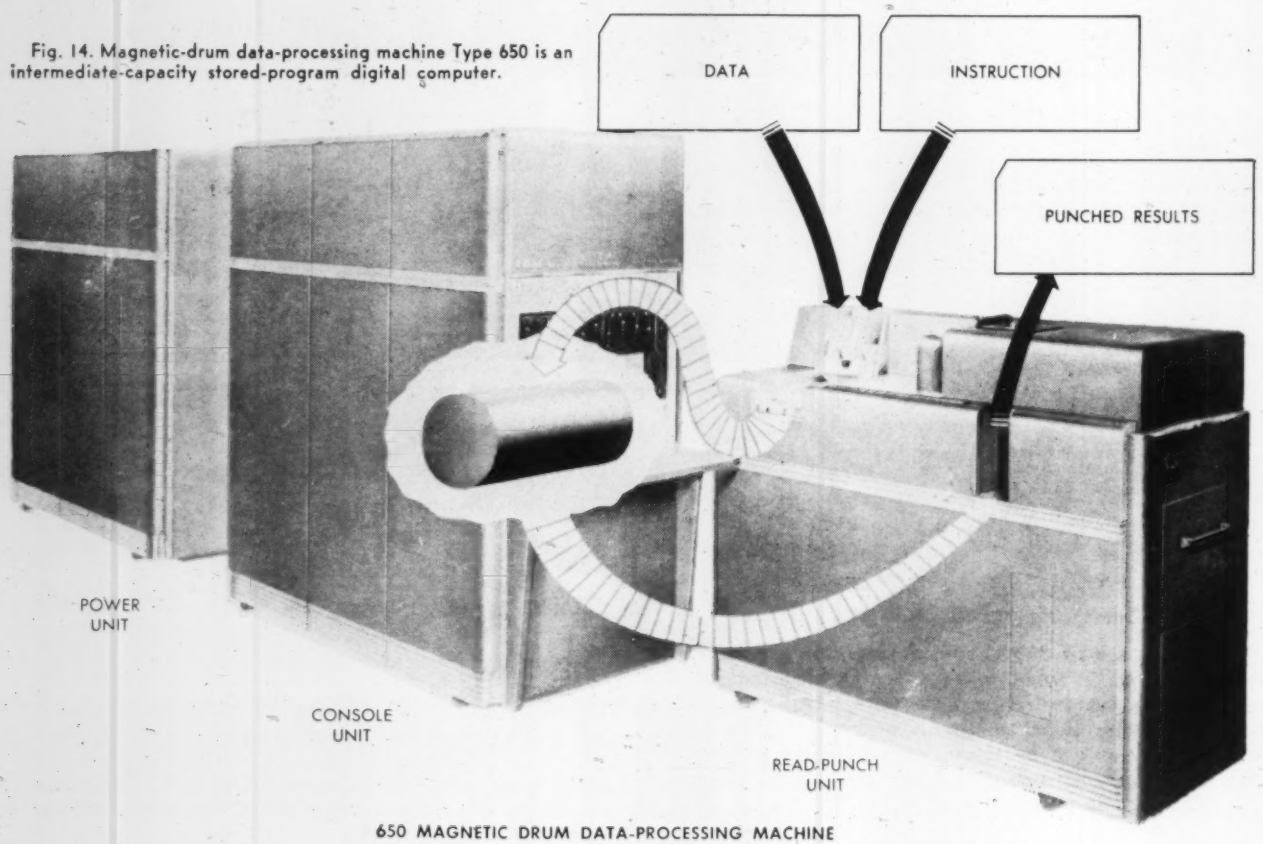


Fig. 13. Card-programmed calculator was first electronic computer which included electronic computing plus high-speed line printing.

Fig. 14. Magnetic-drum data-processing machine Type 650 is an intermediate-capacity stored-program digital computer.



650 MAGNETIC DRUM DATA-PROCESSING MACHINE

held in storage devices in the various machines. The storage unit increases the capacity of the entire machine so that it may handle larger problems.

The calculations are performed at high speed in the electronic calculator (the 605 Calculating Punch in Fig. 13). Upon completion of the calculations, results may be printed in report form by the high-speed line-printer part of the accounting machine, as well as punched into cards by the punch unit.

This machine is used in the preparation of payrolls, general ledger accounting, actuarial studies, statistics, and other business calculations. The majority of these machines (over 200 installed from 1948 through 1954) are used for engineering and scientific calculations, including: cam design, transformer design, fourier harmonic analysis, engine performance, airplane landing gear dynamic analysis, interior and exterior ballistics, stability of feedback systems, lens design, etc.

Intermediate-Capacity Stored-Program Machine

The next IBM machine is the intermediate-capacity stored-program machine, the IBM Type 650 Magnetic Drum Data-Processing Machine (Fig. 14).

The input of both data and instructions is in the form of punched cards. The magnetic drum stores data as well as instructions. Computing and control circuits are electronic. The computed results are punched into cards which may be used to print results in IBM accounting machines. The internal-logic self-checking features, convenient operator's console, and compatible IBM card input and output make this machine flexible and efficient.

More than 200 of these machines will be installed in 1955. Typical problems include insurance premium calculations, market analysis, missile design, pilot-plant data reduction, hydrocarbon gas analysis, etc.

Large-Scale Data-Processing Machines

The final category of IBM machines is one comprising the large-scale electronic data-processing machines. The machines in this class are divided into two groups: the "IBM 701 and 704" which are designed for engineering and research calculating, and the "IBM 702 and 705" which are designed for accounting and record-keeping applications.

It is pertinent that a brief history of the development of these machines be given.

Over six years ago IBM developed a high-speed Magnetic-Tape Electronic Data-Processing System, specifically designed for business. This first commercial data-processing system involved use of magnetic tapes, drums, and high-speed electrostatic memory. This machine, called the Tape Processing Machine, or TPM, was completed and undergoing tests when the Korean situation became critical in June of 1950. At that time IBM was asked if their engineers could utilize some of these components and design a high-speed electronic computer for the use of certain defense agencies of the Government and prime contractors engaged in defense work. As a result of this request, plans for the business machine were shelved, and effort was devoted to the design of a machine system which became known at the IBM 701 Electronic

Fig. 15. IBM 701, large-scale Electronic Data-Processing Machine, is basically a scientific computer. Nineteen are now in operation.

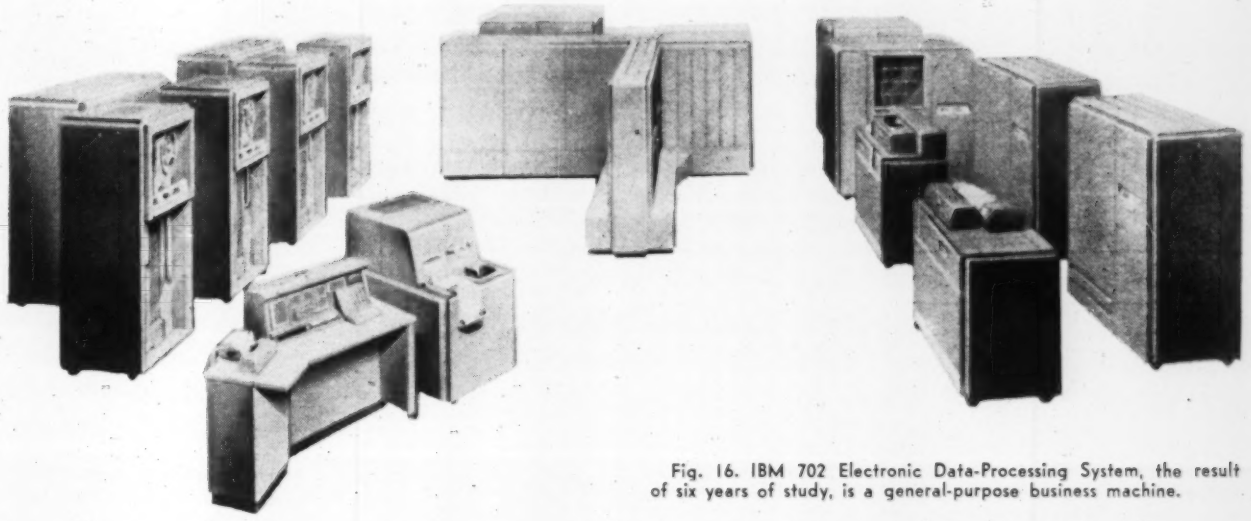


Fig. 16. IBM 702 Electronic Data-Processing System, the result of six years of study, is a general-purpose business machine.

Data Processing Machine. There are nineteen 701's operating today. A photograph of a typical installation is shown in Fig. 15.

The major objective of the 701 was to perform engineering and research calculations. It was determined that a machine similar to the TPM would more adequately perform many business applications. Therefore, as soon as the engineering commitments on the IBM 701 Scientific Computer had been met, the specifications of the TPM business machine were re-examined.

Survey teams totaling forty men were assigned to an eight-months' project of making detailed application studies of the data-processing requirements of representative industries.

Finally, after more than six years of effort and study, the IBM 702 evolved (Fig. 16). A 702 has been operating in the IBM Poughkeepsie laboratory since April, 1954; twelve of these machines will be installed in business offices during 1955. Each of these 702's is a complete Electronic Data Processing System designed specifically for business.

In addition, IBM has announced two data processing machines—the 704 (advanced version of the 701) and the 705 (advanced accounting model, the next model up from the 702). By the end of 1954 over 130 of these IBM Electronic Data Processing Machines were installed or on order.

Computer Fundamentals

Despite the different purposes for which these machines were developed, each of them operates on a few simple concepts. For example, all automatic data-processing machines can be thought of as having five fundamental building blocks (Fig. 17).

Input Devices

Input devices are usually some kind of electromechanical equipment. Information may be entered directly into the machine by an operator who manipulates a set of keys similar to a typewriter or adding-machine keyboard. Information may also be accepted from punched cards, or magnetic tape. Each of these types of input has certain advantages.

A single *punched card* may be easily changed in a file of cards used for input purposes. Also, the information which is punched into the card may also be printed on the card so that it can be read easily by a person without the use of auxiliary equipment. Punched cards at present can move in only one direction through the machine, whereas continuous tape can be moved foreward and backward past the reading unit.

Magnetic tapes on the IBM 700 series record at a density of 200 characters per inch and move at the rate of 75 inches per second. This allows reading and writing at the rate of 15,000 characters each second. Magnetic tapes are now becoming standardized for large data-processing machines in the same way that punched cards have long been used in smaller machines. For example, reels of magnetic tape may be used interchangeably as the "common language" element in the IBM 701, 702, 704, and 705 machines.

Output Devices

Output devices bring information out of the calculator and prepare it in some suitable form for another use. In most cases a printed answer is required. The electric typewriter which was fast enough for printing results from the Automatic Sequence Controlled Calculator in 1944 is not suitable for today's high-speed electronic calculators. One way to get around slow typing speed is to bring information out of the calculator on magnetic tape and then have ten or twenty auxiliary pieces of equipment to process the tape and produce typewritten material.

An *electric typewriter* can print 900 characters per minute while a *line-printing device* can easily print ten or twenty times that fast. For example, the printing unit on an IBM Type 407 accounting machine, (over 3000 of which are in daily use) is capable of printing 18,000 characters per minute.

In connection with the input-output requirements there are two additional problems of particular interest: One is the idea of getting information from one piece of machinery into a computer and the result back into some other piece of machinery without having any human intervention. This type of operation requires what are known as "data-conversion devices." Sometimes the initial information is available in a form such as an electrical voltage. This must be transformed into impulses which can be counted to form the digits in a digital computer. Such a device is often called a "digitizer." Rapid progress is being made in this field.

The other aspect of this input-output situation is that all computer problems do not have the same requirements. A mathematical type of problem is that of computing auto-correlations within a set of 100 numbers. In this

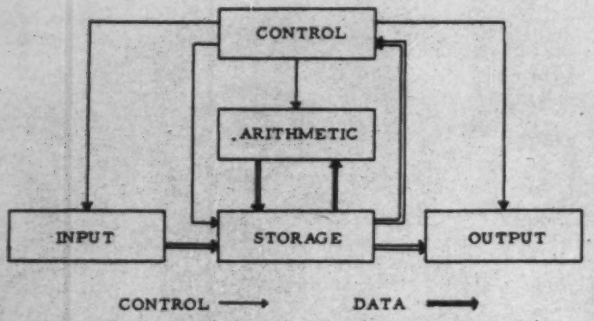


Fig. 17. Fundamental elements of a data-processing machine, or computer.

Table 1.—Development of Storage Capacity and Addition Time of Data-Processing Machines

Calculator	Date	Storage Capacity (Digits)	Addition Time (Microseconds)
Automatic Sequence Controlled Calculator	1944	3,000	300,000
Selective Sequence Electronic Calculator	1948	400,000	20,000
701	1952	8,000,000	60
Naval Ordnance Research Calculator	1954	50,000,000	14

case, an input of 100 numbers would require thousands of calculations to arrive at a few answers. The opposite case is that of an accounting or data-handling problem which might require thousands of numbers of input, very little computing, and then thousands of numbers of output. These two types of problems make different demands on a machine. Most problems lie between these two extremes.

Storage Devices

Before describing the storage devices used in automatic computing machines a few terms need defining:

A *storage device* is a piece of equipment into which information can be introduced and then from which that same information may be extracted at a later time.

A *word* is defined in computer terminology as a group of characters (usually digits) having a meaning and considered as a unit. A word may be either data or an instruction.

An *address* is usually a number which designates a particular location in a storage device.

An *instruction* is information, usually in numerical form, which will cause a computing machine to perform one or more operations. One or more addresses are usually included as part of the instruction.

Rotating wheels and electrical relays were first used as storage devices in computing machines. Then vacuum tubes were used to get faster operation.

Magnetic Tape

Another medium which can be used either for storage or for input-output type of operation is the magnetic tape. As a piece of input-output equipment it operates at relatively high speed. As a storage device, it is sometimes used as a relatively large-capacity but slow-speed random-access device.

The *time scale* of fast and slow must be explained.

In the computer field these days, if a number is not available from storage in a few millionths of a second, the storage system is considered to be relatively slow. To search a whole reel of magnetic tape takes several minutes. On the other hand, the tape is a fairly compact and permanent type of storage. That is, if the power should fail for a computing machine, the information stored on tapes will not be lost.

Magnetic Drum

The next obvious step is to prepare a short, wide, endless magnetic tape on a cylindrical form. Such a device is called a *magnetic drum*. A magnetic drum is kept rotating at all times, while a magnetic tape is moved only when it is called for. Information is stored on the magnetic tape or drum surfaces as small "spots" of magnetism. More than one thousand such spots may be placed on a single square inch of surface. Each spot represents information. The information may be read from the surface over and over, if desired, and it may be replaced by different information. The magnetic drum represents a compact type of storage device and any information on the surface of the drum is available in a few thousandths of a second.

Cathode-ray Tube

A much faster type of storage device is the *cathode-ray tube*. This electrostatic storage unit is similar to the picture tube in a TV set. Hundreds of spots of information may be stored on the face of such a tube. The most important characteristic of this storage device is that there is no waiting for a particular spot to become available for reading. Information is thus available in a few millionths of a second. It is sometimes called an instantaneous random-access type of storage, and has been used in the IBM 701 and 702.

Magnetic Cores

An even newer device is now being used in the IBM 704 and 705—magnetic cores. These devices are tiny, doughnut-shaped objects that can "remember" information indefinitely, and recall it in a few millionths of a second. A network of ferrite magnetic cores is strung on screens of wire. When current is passed through a pair of wires it causes the core affected to store the data involved. Information is called out of memory by reversing the process and reading the stored data by means of a third wire.

Cores are extremely stable and will last indefinitely. Their small size permits large storage capacity to be housed in relatively little space. The 705 has capacity for the storage of 20,000 characters, any one of which can be located and transferred in seventeen millionths of a second.

There are other types of storage devices being studied. Here again is a field in which new developments are being made very rapidly.

Incidentally, no one has come even close to designing a storage device which is as compact and as efficient as the brain. The human brain can store thousands of pieces of information and also process them and associate them in thousands of ways.

Arithmetic Unit

The arithmetic unit is a combination of electronic circuits which does the actual processing of data under the direction of the control unit. Some machines use the decimal system, some machines use a modified decimal and binary system, and other machines use the binary system. Still other number systems may be used, each

Table 2.—Operational Characteristics of NORC, the World's Most Powerful Calculator.

NUMBER SYSTEM:

Decimal throughout.

MODE OF OPERATION:

Serial by digit.

WORD SIZE:

Sixteen digits and check.

INSTRUCTIONS:

Sixty-three different three-address operations.

TAPES:

Number of tape units—Eight.
Density—510 characters an inch.
Speed—140 inches a second.
Information rate—70,000 characters a second.
Starting time—Eight thousandths of a second.

ELECTROSTATIC MEMORY:

Number of words—Two thousand.
Access time—Eight millionths of a second.

ARITHMETIC:

Decimal point procedure—Automatic floating or specified.
Multiplication time—Thirty-one millionths of a second.
Addition time—Fourteen millionths of a second.
Complete operations, including floating decimal point, address modification—15,000 a second.

PRINTING:

Number of printers—Two.
Speed—18,000 characters a minute.

system having its advantages and disadvantages in terms of speed and equipment.

The arithmetic or processing unit performs the usual operations of addition, subtraction, multiplication, and division on numerical data. Of at least equal importance is its ability to perform comparisons. It was this ability to make comparisons which allowed the IBM 701 to demonstrate the translation of Russian language text into English language text.

Control Center

The control center tells the machine where to get data, what operations it is to perform and where to place the answer. The control center is only following a sequence of instructions which has been stored in the computer. A sequence of operations is called a *program*.

Some machines are controlled by wired control panels. Other machines are controlled by a "stored program." In a stored-program machine the instructions for doing arithmetic are coded as a set of numbers and stored in the machine. The instruction numbers are automatically sent to the control section one at a time. Each number is interpreted and causes the appropriate other parts of the machine to perform their set functions.

Installation and Application

The average time to install each of the eighteen 701's in their many different operating locations was only five days. One of the machines was installed and completely tested in only 18 hours.

The installation shown in Fig. 15 is used by the IBM Scientific Computing Service in New York City. This machine is kept busy 24 hours a day doing computing for people who have only occasional need for large-scale computing facilities. Some of the problems solved at this installation include problems associated with heat exchanger rating, gasoline blending by linear programming, factory production scheduling, missile trajectories, nuclear reactor behavior, optical ray tracing, etc.

Probably the most outstanding contributions of the large EDPM equipment will be in the field of management science and operations research. For example, the distribution of overhead costs is important in cost accounting. A bank has done this for 156 departments. By desk calculator this work required more than 1000 man-hours. The 701 in IBM's Scientific Computing Service

Fig. 18. NORC, the world's most powerful computer.

solved this problem and printed the 156 required answers in 9 minutes.

An oil company used the same machine for 6 hours to reschedule its seasonal production for maximum profit. The profit had previously been calculated to be $800,000. After the new schedule was prepared by the machine, the new profit was calculated to be $3,700,000.

IBM has already used the 701 to calculate a one-year manufacturing schedule of one of its assembly lines. This and other similar scheduling jobs are done in a few hours. The detailed results of these machine-produced schedules were impossible to obtain by hand methods.

People sometimes wonder if there is enough work to keep a large calculator busy. The 19 Type 701's are in daily use for an average of more than 2 shifts, and many of these installations have additional computing equipment on order. Each of three computing groups already has two of these machines. This plus the order for more than one hundred of the large IBM EDPM machines is ample proof of the need for this type of equipment.

The data-processing machine field has developed rapidly. A few numbers will serve to illustrate the rapid progress being made. Table 1 shows the total storage capacity and addition times of some representative large-scale digital computers built by IBM, with the dates the machines were first put in operation. The table shows that in only 10 years both the size of the problem which could be handled and the speed of solution have increased by more than 10,000 times.

A great deal of this remarkable increase should be attributed to the money and effort put into research and development programs. For example, in 1954 IBM spent more than $14,000,000 in this kind of work.

The biggest calculator ever constructed is the NORC (Naval Ordnance Research Calculator) built by IBM for the Navy's Bureau of Ordnance. The NORC is shown in Fig. 18. Facts concerning its operation are in Table 2.

Conclusion

As has been described, electronic data-processing machines (EDPM) range from a simple card punch to powerful electronic calculators.

There is nothing particularly profound or high-brow in the application of the concept of automation in the field of data processing. A person needs some general knowledge of the capabilities of data-processing systems, an introduction to which has been given. He also needs some imagination, an open mind, and the willingness to adopt new procedures when such a change promises to be advantageous.

IBM maintains an extensive education program to train customer personnel. In 1954, more than 40,000 customer employees were trained in the operation and application of various IBM machines.

Process Control Analysis

Second step in describing a closed-loop control system mathematically is development of the mathematical expression for the control system —including measuring element, controller, final control element, and transmission lines. This is done for a 3-response controller. Clear descriptions of the system constants are of particular value.

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II
The Controller Equations

CLOSED-LOOP CONTROL SYSTEM consists of the process, measuring element, controller, and final control element. The automatic controller receives a signal from a measuring element, and transmits a corrective signal to the final control element (Fig. 2-1). For our purpose, we will consider the measuring element, its transmission system, the final control element, and its transmission system as a part of the controller circuit.

In the previous chapter the basic equations (mathematical descriptions) of 1-, 2-, and 3-capacity processes were developed, in terms of the inflow (F) to a liquid level process, the controlled variable (x), and the process constants. It is our objective in this chapter to establish equations of the *controller portion* of the circuit in terms of F, x, and the *controller* constants.

Ideal Controller Circuit

Let us assume that the entire control section is "ideal" —that is, that there is no time delay between receiving a signal and the transmission of that signal to the succeeding element. Fig. 2-1 represents a single-capacity process and the "ideal" controller circuit. Essentially, what we are assuming in Fig. 2-1 is that there is no capacity or resistance in the measuring system, the controller, or the final control element. Thus a change in level from the desired value will result in an immediate change in inflow to the process.

Control Modes

The basic types of automatic control that will be considered are (1) proportional, (2) reset, or integral, (3) rate, or derivative, (4) combination of proportional plus reset, (5) combination of proportional plus rate, and (6) combination of proportional plus reset plus rate.

Proportional control is a mode of control action in which the output is proportional to the input signal.

Reset, or integral, control is a control action in which the output changes at a *rate* which is proportional to the *magnitude* of the input signal.

Rate, or derivative, control action is one in which the magnitude of the output is proportional to the *rate* of change of input. The mathematical expressions for each of these three controller actions are:

Proportional

$$F = -\alpha\,(x - x_o) + F_o \qquad 2.1$$

Reset

$$F = -\gamma \int (x - x_o)\,dt + F_o \qquad 2.2$$

Rate

$$F = -\beta\,(dx/dt) + F_o \qquad 2.3$$

Proportional plus Reset plus Rate

$$F = -\alpha\,(x - x_o) - \gamma \int_{\bullet}^{t} (x - x_o)\,dt - \beta\,dx/dt + F_o \qquad 2.4$$

In these equations, the constants α (proportional), γ (reset), and β (rate) represent the over-all control factors which relate the input (change in level in feet) to the output (change in flow in cubic feet per minute) and thus are *not* the adjustments found in commercial controllers. The negative sign on the right-hand side of Equations 2.1 to 2.4 has been used to obtain the proper corrective action from the controller. For example, if the level (x) should rise, the controller should act to decrease the flow (F) in order to restore the level towards the desired value (x_o). F_o represents the initial value of inflow F.

Units of α, γ, β

The units of α, γ, and β for the liquid-level process shown in Fig. 2-1 are:

α = cubic feet per minute flow, per foot of level error

γ = cubic feet per minute flow, per minute, per foot of level error

β = cubic feet per minute flow, per foot per minute of level velocity

A dimensional check on the units of α, γ, and β for the liquid-level process gives: $\alpha = ft^2/min$; $\gamma = ft^2/min^2$; $\beta = ft^2$. 2.5

The dimensions of α, γ, and β will depend on the particular process application. For example, if it were tem-

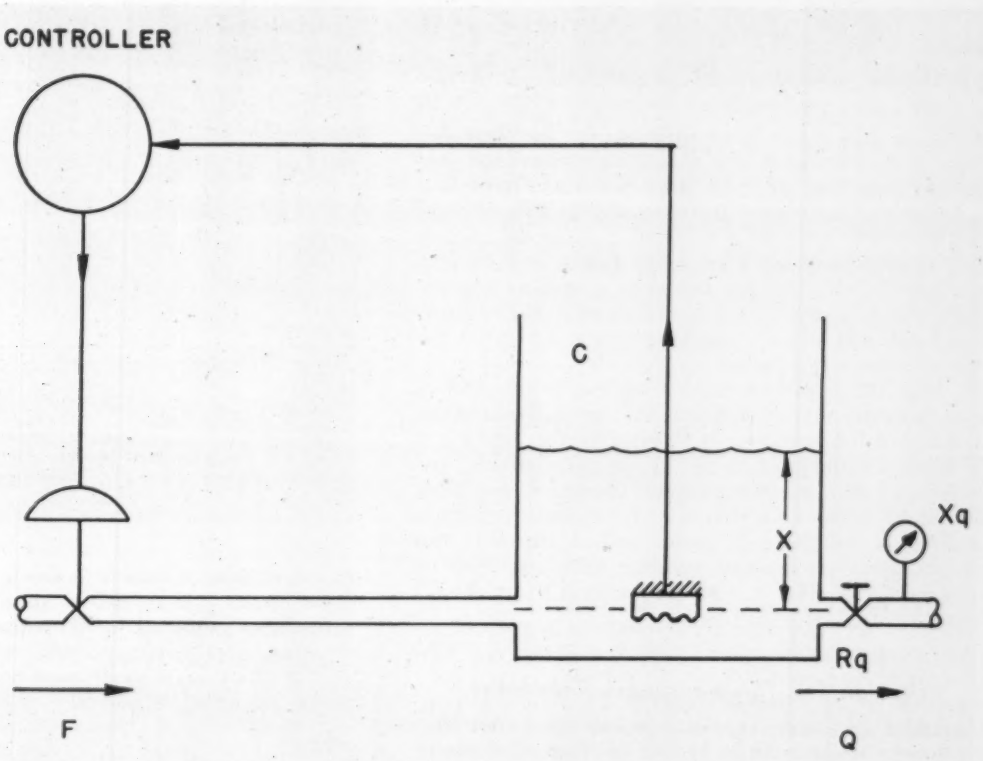


Fig. 2-1. Single-capacity process and "ideal" controller, valve, and measuring system (ideal in the sense that there are no time lags).

perature, rather than liquid level that we were controlling, the units of a would be pounds of steam per minute per degree F input signal, or perhaps BTU's per minute per degree input signal (depending on the choice of the investigator). If it were pressure that we are controlling, the units of a would be pounds of gas per minute per psi input signal.

Effect of Lag in Valve Line

Fig. 2-2 shows a simplified drawing of a liquid-level process and a controller circuit possessing one lag in the section between the controller and the final control element. This lag is present in pneumatic control circuits because there usually is a long transmission line between the controller and the valve, and the valve diaphragm itself usually has appreciable capacity. This lag is represented in Fig. 2-2 as a resistance-capacity stage. The nomenclature used in this figure is:

p_c = pressure at exit of controller in psi
p_{co} = initial value of the pressure at the exit of the controller in psi
p_v = pressure on the valve diaphragm in psi
p_{vo} = initial value of the pressure on the valve diaphragm in psi
F_v = flow of air through resistance R_v to the valve diaphragm in pounds per minute
R_v = resistance in transmission line between controller and final control element in psi per pound per minute flow
C_v = capacity of the valve diaphragm in pounds per psi

For a proportional controller, the change in output is proportional to the change in input. We can express this mathematically:

$$p_c - p_{co} = -a(x - x_o) \qquad 2.6$$

where "a" represents a controller constant which converts the measuring signal into the appropriate pneumatic signal from the controller. The units of "a" in this case would be psi output per foot change in input. It is the controller gain, and will be combined later with the valve factor to form the over-all circuit proportional-control-factor a.

The change in flow through the control valve (assuming a linear valve) will be proportional to the change in pressure on the valve diaphragm. This can be expressed mathematically:

$$F - F_o = b(p_v - p_{vo}) \qquad 2.7$$

where "b" is a valve constant related to the valve characteristics. It will be called a *valve factor*, and the units of "b" in this case will be cubic feet per minute per psi.

The flow through the resistance, R_v, which occurs when there is a change in output from the controller, can be expressed:

$$F_v = (p_c - p_v)/R_v \qquad 2.8$$

which simply states that the flow through the resistance is proportional to the pressure drop and inversely proportional to the resistance (Ohm's law for flow).

The rate of change of pressure on the diaphragm of the control valve is proportional to the net inflow or outflow from it, and inversely proportional to the valve capacity—that is,

$$dp_v/dt = F_v/C_v \qquad 2.9$$

If we combine Equations 2.8 and 2.9, we obtain the following equation for this section of the controller:

$$T_v\, dp_v/dt = p_c - p_v \qquad 2.10$$

where

$$T_v = R_vC_v \qquad 2.11$$

In Equation 2.10 we need an expression for the quantity $(p_c - p_v)$ because we want the final equation to be in terms of F and x only. This can be obtained by subtracting Equation 2.6 from 2.7, remembering that $p_{co} = p_{vo}$:

$$p_c - p_v = -(1/b)(F - F_o) - a(x - x_o) \qquad 2.12$$

In Equation 2.10, we need also a relationship for the rate of change of pressure in terms of flow. This relationship exists in Equation 2.7. Differentiating Equation 2.7, remembering that F_o and p_{vo} are the initial values of flow and valve pressure respectively, (and thus constants whose differentials are zero), we obtain:

$$dp_v/dt = (1/b)(dF/dt) \qquad 2.13$$

Substituting Equations 2.12 and 2.13 into Equation 2.10, we obtain:

$$T_v\,dF/dt + F = -a\,(x - x_o) + F_o \qquad 2.14$$

where

a = ab, the over-all circuit proportional-control factor 2.15

Equation 2.14 is the final expression for the controller section of the loop where the measuring element and proportional controller are both ideal, but where there is a lag in the circuit between the controller and the control valve. In short, we have considered a controller section which contains one lag. Comparing Equation 2.14 with Equation 2.1, we note that the *effect of adding one lag in the control portion of the loop is to raise the order of the equation.* It will be found that each lag raises the order of the equation by one.

T_v is an important constant. It represents the effect of lag in the valve circuit, and it is the factor which raises the order of the equation. It is equal to the product of the resistance and capacitance in the valve circuit, and has units of time, such as minutes. Therefore, it is often referred to as the *time constant* of the circuit. As it is effectively a resistance in series with a capacity, this "time constant" is the time constant associated with an exponential rise (that is, time for variable to reach 63.2 percent of its final value).

Equation for Three-response Controller

Equation 2.14 involves only a proportional controller. The same procedure can be applied to other types of control responses. For example, for a three-response controller (proportional plus reset plus rate) we could write immediately for the change in output from the controller the following:

$$p_c - p_{co} = -a\,[(x - x_o) + R\int_o^t (x - x_o)\,dt + T\,dx/dt] \qquad 2.16$$

Comparing this with Equation 2.6 (where only proportional control was used) it is noted that the only change is the addition of the reset and the rate control effects. If the same analysis (involving the flow of air into the control valve and the relationship between the diaphragm pressure and the flow to the process) were repeated, we would obtain the following expression for the control portion of the loop:

$$T_v\,dF/dt + F = -a(x - x_o) - \gamma\int_o^t (x - x_o)\,dt - \beta\,dx/dt + F_o \qquad 2.17$$

where a = ab; γ = abR; and β = abT 2.18

In relationships 2.18, "R" is the reset rate in repeats per minute, and "T" is the rate time in minutes, (which are the adjustments of these two responses available in most commercial controllers).

Effect of Lag in Measuring Circuit

If, instead of lag in the valve circuit, we consider lag in the measuring portion of the control circuit (Fig. 2-3) the analysis would be identical. The only difference between Fig. 2-2 and 2-3 has been the shifting of the resistance and capacity to the measuring section of the controller circuit.

This situation occurs frequently in temperature elements where appreciable lag occurs in the transfer of heat from the process fluid to the thermometer-sensing element. Often, this lag is considerably more than that occurring in any other portion of the control circuit and, therefore, it is the one which must be considered above the others. (The controller itself usually has negligible lag in comparison with lags in the measuring circuit or the valve circuit.) If we follow an analysis identical to the procedures employed for the valve lag, we obtain:

$$T_m dF/dt + F = -a(x - x_o) - \gamma\int_o^t (x - x_o)\,dt - \beta\,dx/dt + F_o \qquad 2.19$$

where

$$T_m = R_m C_m \qquad 2.20$$

Equation 2.19 involves a controller with proportional plus reset plus rate control. It is identical to Equation 2.17 (where the lag was in the valve portion of the circuit). The only difference lies in the substitution of T_m (or $R_m C_m$) in place of T_v (or $R_v C_v$). These quantities are frequently called "time constants" because they represent a multiplication of a resistance and a capacity—and dimensionally the units of RC are units of time, such as minutes.

In practice, it is usually possible to evaluate the time constant T_v or T_m for a given valve or measuring element, respectively. This can be done either mathematically or experimentally. Manufacturers often can provide this information.

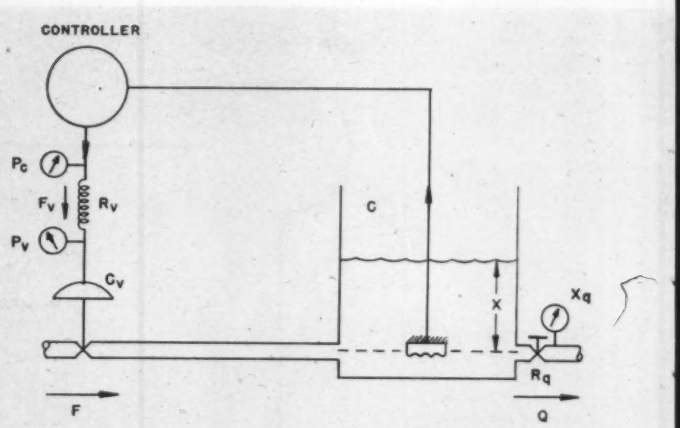


Fig. 2-2. Single-capacity process with ideal controller and measuring system, but with lag in the valve circuit.

Effect of Lags in Both Measuring Circuit and Valve Circuit

Our final step in developing equations for the control section of the system is consideration of a lag on both sides of the controller (Fig. 2-4). We will treat the controller as ideal because usually the controller lag is negligible compared to lags in the other sections of the loop. The system to be studied now contains two lags, and we can expect that a second-order equation will result. Considering proportional control only (in order to avoid lengthy expressions) we can write the following equations for the measuring and valve sections of the loop, respectively:

$$T_m dp_m/dt = p_x - p_m \qquad 2.21$$

$$T_v dp_v/dt = p_c - p_v \qquad 2.22$$

Equation 2.22 is identical to Equation 2.13 for the valve section of the loop. Equation 2.21 is obtained by following the procedure used to obtain Equation 2.10.

Pressure p_x in the measuring element is directly proportional to a change in control variable $(x - x_o)$, therefore:

$$p_x = c(x - x_o) + p_{xo} \qquad 2.23$$

where "c" is simply a conversion factor to give us an

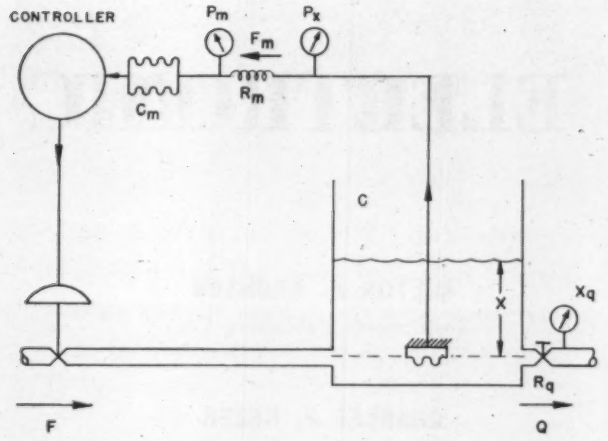


Fig. 2-3. Single-capacity process with ideal controller and valve, but with lag in the measuring system.

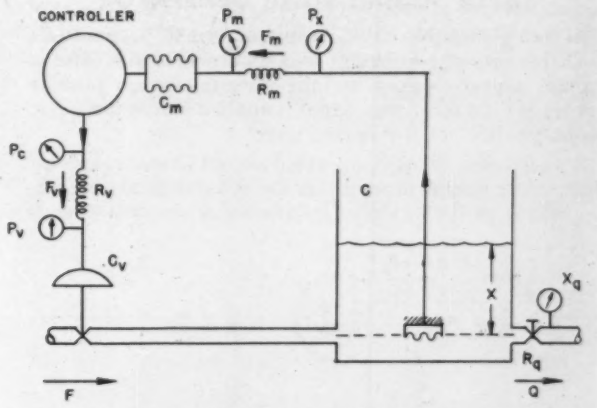


Fig. 2-4. Single-capacity process with ideal controller, but with lags in both measuring and valve circuit.

expression for "p_x" in pneumatic units, such as psi; for a liquid-level process, "e" has the dimensions of psi per foot. Terms x_o and p_{xo} represent the initial values of the level and the measured pressure, respectively.

Passing through the controller (a proportional controller) we can write the following equation for the output from a pneumatic instrument:

$$p_c = -a(p_m - p_{mo}) + p_{co} \qquad 2.24$$

where "a" represents the gain in passing through the controller. It will be combined with other terms to provide us the over-all proportional control factor α. The terms p_{mo} and p_{co} represent the initial values of the input and output pressures respectively.

The change of flow through the control valve (a linear type) is directly proportional to a change in diaphragm pressure:

$$F = b(p_v - p_{vo}) + F_o \qquad 2.25$$

where b represents the valve factor and has the units of cubic feet per minute per psi.

Equations 2.21 to 2.25 inclusive provide the necessary relationships to obtain the final expression for a proportional control circuit having two lags:

$$(T_m T_v)\,d^2F/dt^2 + (T_m + T_v)\,dF/dt + F = -\alpha(x - x_o) + F_o \qquad 2.26$$

where the time constants T_m and T_v are the product of the resistance and capacity in each section of the loop, respectively. This is the final expression for a proportional controller.

Three-response Controller

Let us now consider a three-response controller containing proportional plus reset plus rate control actions. The effect of additional responses is to alter Equation 2.24 (the expression relating the input and output of the controller) as follows:

$$p_c = -a\left[(p_m - p_{mo}) + R\int_o (p_m - p_{mo})\,dt + T\,dp_m/dt\right] + p_{co} \qquad 2.27$$

Combining Equation 2.27 with Equations 2.21 to 2.25 inclusive, and using Equation 2.27 instead of Equation 2.24, we obtain as our final equation:

$$(T_m T_v)\,d^2F/dt^2 + (T_m + T_v)\,dF/dt + F = -\alpha(x - x_o) - \gamma\int_o (x - x_o)\,dt - \beta\,dx/dt + F_o \qquad 2.28$$

where $\alpha = abc$; $\gamma = abcR$; $\beta = abcT$.

Equation 2.28 is general for the case of two time lags in the control section of the loop. It will be used in the next chapter to obtain the closed-loop system equations. To use Equation 2.28 for cases involving only one lag, one of the lag terms (T_m or T_v) is equated to zero. Also, to use Equation 2.28 for cases involving one or two control effects, it is necessary to equate the omitted controller constant to zero. For example, if reset control were absent, γ would be set equal to zero. Consequently, Equation 2.28 is a general expression for the control part of the loop for an ideal controller and single lags in either the valve or measuring sections of the controller circuit.

Conclusion

We have developed the equations for the controller section of the loop for a three-response controller and a system involving two time lags—one in the measuring section and one in the valve section. These represent situations often encountered in practice. As more lags are included, the analysis becomes more complex. We have omitted consideration of lag within the controller because this usually is negligible in comparison to the others. However, additional lags can be included by following the same procedures. Almost all applications involve distributed capacities, and it is well known that in the analysis of such systems the greater the number of capacities that are taken into account, the higher is the accuracy. Evaluation of these lags and the need for taking them into account can be determined without difficulty after a little experience is gained in using these procedures on actual systems.

We have completed (in Chapter I and II) the establishment of the process and controller equations, respectively. There is one step remaining—to obtain the closed-loop equation which would be used in the final analysis of a complete, automatically controlled system. This analysis will tell us exactly what may be expected of a given process and control system without having the physical plant before us. The ultimate objective in all analyses is to predict the performance that may be expected while a system is still in the design stages. This procedure eliminates costly alterations and takes the guess work out of control-system design. In the next chapter we will combine the equations in Chapter I and Chapter II to obtain the final expressions for automatically controlled processes involving both simple and complex systems.

ELECTRONIC

MILTON H. ARONSON
Instruments Publishing Co.

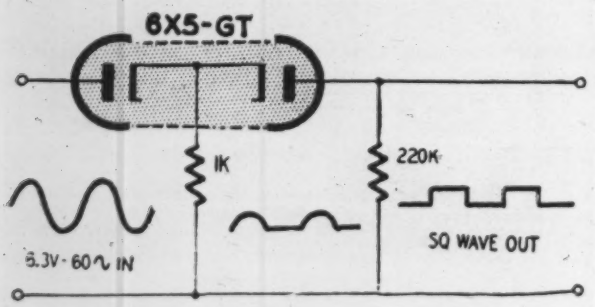
and

CHARLES F. KEZER
Potter Instrument Co.

SIMPLE SQUARE-WAVE GENERATOR

At first glance this circuit would appear to pass nothing at all because it consists of two diodes in series, one to clip any negative signal, and the other to clip any positive signal; yet if a 6.3-v rms signal is applied across the input, the output is a —0.3 v square wave.

Actually, the input sine wave does not pass through the diodes; the output depends on the self-potential (or Edison effect) of the diodes. To understand the operation of



the circuit, suppose no signal is applied at the input. Free electrons in the right-hand diode would move to the plate, producing a negative 0.3 v d-c potential across the output resistor. (A current will circulate in the circuit made of the right-hand diode and the two resistors, and a smaller potential will appear across the smaller resistor also.)

Now apply the input. On negative half cycles the left-hand diode is cut off and the negative 0.3-v signal appears at the output; on positive half cycles the left diode conducts, and a positive half cycle appears at the common cathode. As soon as this potential reaches 0.3 v, the right-hand diode cuts off and the output voltage rises to ground potential. The rise is vertical because only the vertical small portion of the input signal near ground potential affects the operation. When input goes negative again, the output drops to the —0.3 v value. Hence output is a square wave.

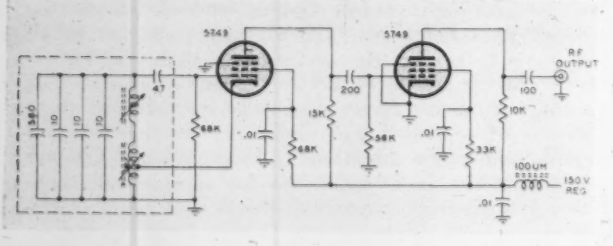
Self-potential of left-hand diode has minor effect because of low impedance of source and low value of input resistor. Circuit can be used at higher frequencies, with circuit capacitance setting the upper limit.

Source: D. Ketchum, American TV Labs of Calif., Hollywood, Calif. Also *Radio-Electronics*, November, 1954.

PERMEABILITY-TUNED RF OSCILLATOR

This oscillator approaches crystal stability while affording a tuning range of 2:1, a good example of the results that can be obtained from conventional circuitry by close attention to electrical and mechanical details.

Oscillator is an electron-coupled Hartley circuit and a buffer amplifier. Temperature compensation is achieved by using ceramic negative-temperature-coefficient capacitors as required. A temperature-controlled oven holds temperature of tuning elements within limits. Two type



5749 miniature pentode tubes (a rugged, quality-controlled version of the 6BA6) are used.

Frequency range: 1.5 to 3.0 Mc.

Max. frequency drift (40 to 120 F): 600 cps.

Max. drift for 10-percent supply voltage change: 100 cps.

RF Output: 5 to 13 v rms, no load.

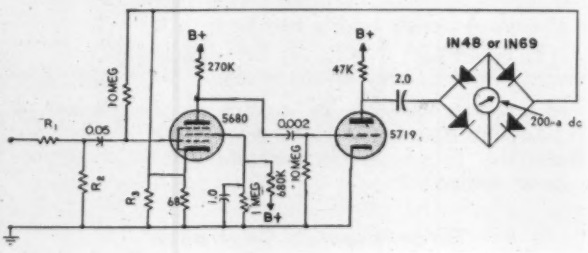
B Supply: 150 v dc at 12 ma.

Heater: 12.6 v at 300 ma.

Source: Collins Radio Co., Cedar Rapids, Iowa, in *Collins Signal*, Winter, 1954.

AC VTVM

This high-impedance ac vacuum-tube voltmeter occupies no more panel space than the 3½" meter. The amplifier uses subminiature tubes, with negative feedback for stability. Germanium diodes are used in the full-wave



rectifier bridge which drives the 200-microampere meter movement. Alternating-current return path of the rectifier bridge is through the cathode resistor of the first amplifier stage to obtain negative feedback. Grid resistor of the first stage is returned to the cathode so that bias of this stage is independent of level. Sensitivity may be as high as 10 mv full scale; lower sensitivities may be obtained by selecting the proper values for R1, R2, and R3.

B Supply: 125-300 v at 3 ma max.

Heater Supply: 6.3 v at 450 ma.

Sensitivity: 10 mv rms to 300 v rms.

Input impedance: 1 megohm or higher.

Frequency range: 20 cps to 50 kc.

Accuracy: 3 percent.

Source: Trio Laboratories, PO Box 143, Wantagh, N. Y.; also *Electronic Design*, April, 1954.

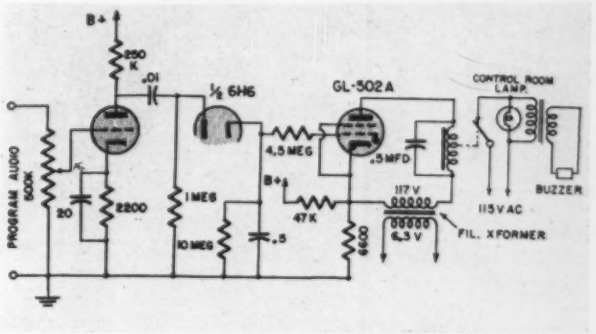
CIRCUITRY

The circuit is the heart of all electronics. Here are five more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

SIGNAL-LOSS ALARM IS FAIL-SAFE

Many circuits have been devised by broadcasters to provide audible and visual alarm when carrier or modulation fails. The alarm circuit itself could also fail, and thus defeat its function. This circuit, however, will sound the alarm if the alarm circuit itself fails.

The buzzer and lamp alarm are normally prevented from operating by a relay which is operated by the GL-502A thyratron, which is continually fired by the rectified (positive) program voltage at its grid. Plate supply of the thyratron is 60 cps ac (supplied by filament transformer connected to 6-v winding on power transformer); hence it fires at the 60-cps rate, cutting off during negative half-cycles of its plate voltage. Thus, if the signal is lost, or if the thyratron, 6H6 diode, or the input amplifier stage



(6SQ7) were to burn out, the alarm would sound. (Consequences of an occasional false alarm are not serious.)

When signal is lost, grid voltage of the thyratron is maintained for about 10 seconds while the 0.5-uf capacitor leaks off through the 10-meg resistor in the 6H6 circuit (without this delay, the alarm would operate on any slight lull in program). About 10 volts of signal into the 6H6 is needed to maintain the thyratron in firing condition; delay interval before alarm sounds is adjustable (up to 30 sec.) by 500K potentiometer at input. With 10,000-ohm relay coil, relay current is about 12 ma.

B Supply: 235 v at 40 ma.

Source: E. C. Smith, Radio Station WFIN, Findlay, Ohio; also *Tele-Tech & Electronics Industries*, Jan., 1955.

TRANSIENT PEAK VOLTMETER

This voltmeter measures the positive peak of an applied transient voltage and holds its value on a panel meter for sufficient time for the observer to read and record it. Input attenuator selects 30, 100, and 300 volts full-scale range. Input cathode follower feeds signal to a short-time-constant pulse-stretching circuit (1N54 diode and 0.03-ufd capacitor). A second cathode follower drives the long-time holding circuit.

The positive signal at the second cathode follower output charges the holding 0.015-ufd capacitor via the 6AL5 diode. The negative voltage remaining on this capacitor *after the transient* is indicated by meter in cathode circuit of the two 6C4 tubes. Input tube of the metering circuit is operated as a cathode follower with low plate voltage and low current density to minimize grid currents; second 6C4 is zero-adjust tube. Tubes 6AL5 and first 6C4 should be mounted in low-loss sockets because no leakage can be tolerated at point marked by arrow. A "push to clear" button resets meter to zero by discharging 0.015-ufd holding capacitor.

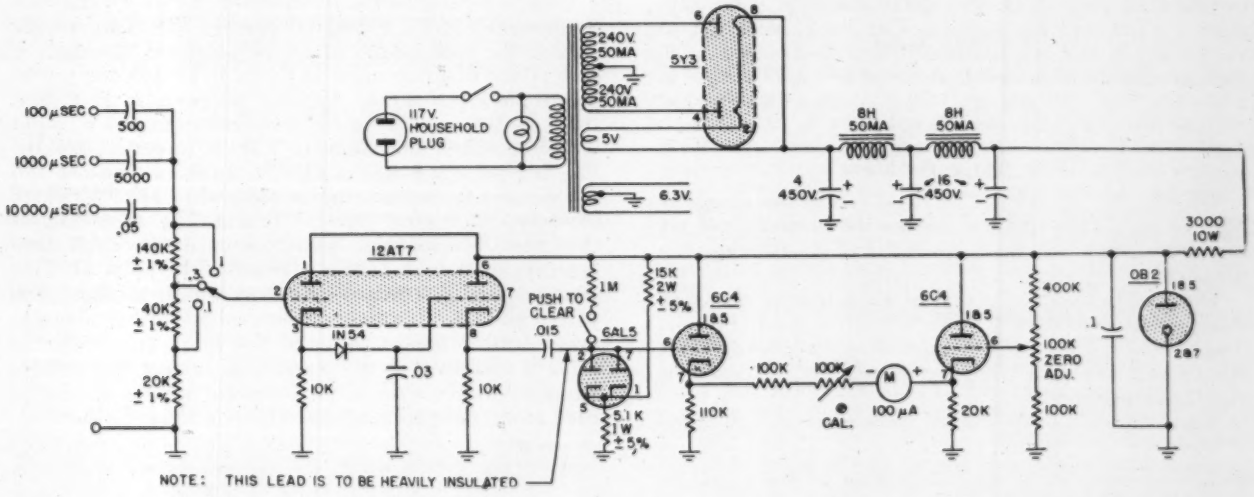
Input impedance: 200,000 ohms.

Response (rise) time: 100 usec to 90 percent of full value.

Accuracy: Equivalent to a conventional VTVM plus or minus 3 percent of full scale.

Holding time: Depends on quality of components and ambient humidity. Typical range of decay is 10 percent of full scale per min.

Source: Richard F. Blake, "An Impulse Vacuum Tube Voltmeter," NRL Report 4274, NBS, Washington, D. C.



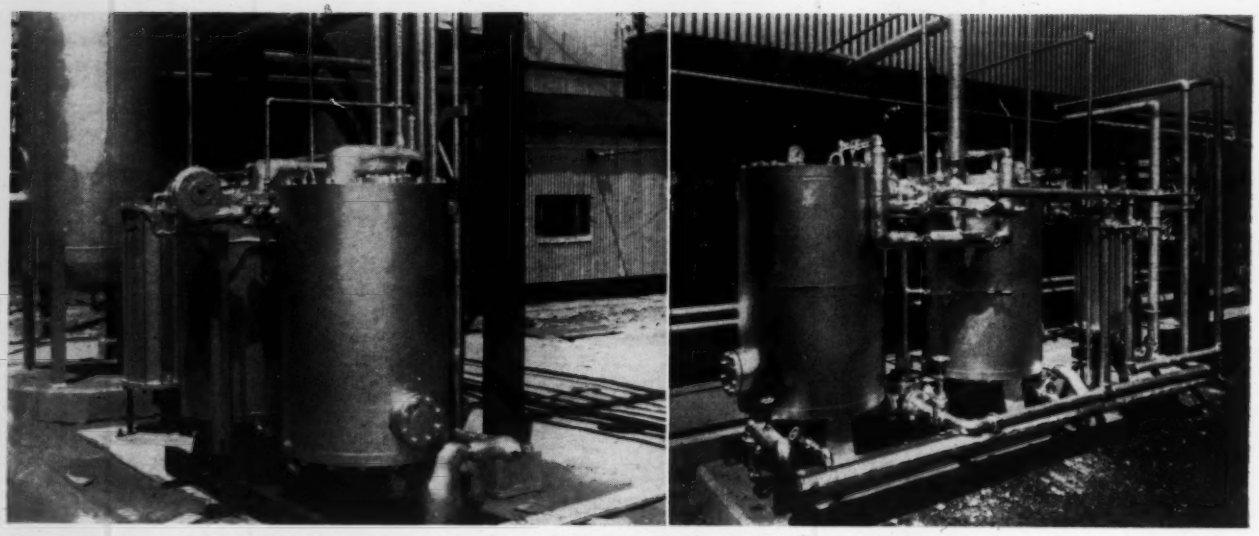


Fig. 1. Typical instrument-air installations. Left, dryer for instrument air to catalytic unit at Panhandle Refining Co., Wichita Falls, Texas. Right, unit at Stanolind, Burnell, Texas.

INSTRUMENT-AIR DRYERS

Economic factors in the selection of appropriate instrument-air dryers include consideration of all psychrometric factors, the oil content of the air, the load, and use of combined separator, precooling, and desiccant techniques. Reliability considerations often over-ride all other factors.

G. L. SIMPSON

Pittsburgh Lectrodryer Corp.

IN 1932 there was only one manufacturer in the United States who built a standardized line of equipment to dry compressed air. Today, 23 years later, there are at least ten companies who offer equipments for instrument-air drying alone. This is dramatic evidence of the growth of our industry and the importance of the instrument-air dryer.

It is not known when the first instrument-air dryer was installed. In 1939, a Houdry plant was built with automatic control and air dryer at Flat Rock, Michigan to (according to the specifications) "dry 75 standard cubic feet per minute of compressed air at 50 pounds gage to a dewpoint of –20 degrees." This machine was tagged "Dryer for Instrument Air Supply."

The Basic Problem

Why buy an instrument air dryer? Why not compress high enough, then cool and reduce the pressure and get air dry enough for the purpose? Let us examine this proposition.

The psychrometry of a typical air system is shown in the angular-perspective 3-D psychrometric chart (Fig. 2). The base of this figure is the normal psychrometric chart for atmospheric pressure (14.7 psia). The vertical axis represents pressure.

Air to the right of the curved plane marked "saturation face" is unsaturated with water vapor. For example, consider air at point 5 (100 psia and 95 F). This air can be used (at 100 psia) at temperatures down to 30 F before it becomes saturated. That is, it has a dew point of 30 F. This is shown by the line extending from point 5 to point 6, which is the point at which the air becomes saturated. (The dew point is the temperature at which the moisture in the air begins to condense.)

Point 1 represents the condition of air as it enters the compressor—at 85 F and 60 percent RH. The specific volume for each pound of air is 14.03 cu. ft.—that is, each pound of air occupies 14.03 cu. ft. In the compressor, polytropic compression (varying temperature and pressure) to 100 psia raises the temperature to 384 F, point 2, and decreases the volume to 3.21 cu. ft. per lb. dry air. The dew point is raised to 133.9 F. In the aftercooler and the receiver the temperature is reduced to 133.9 F, where condensation begins (point 3 in Fig. 2); as cooling is continued, condensation continues until the lowest temperature is attained, in this example 95 F (point 4). This saturated air is available for distribution at about 100 psia at point 4. This air must be used at 95 F or above to avoid further condensation in the lines. If a reducing valve is used to drop the pressure to 20 psia, the relative humidity will be reduced to 20 percent and the air can be used at any temperature above 63 F without further condensation.

A drying system which will remove water vapor from point 4 to point 5, a difference of 0.0046 lb water vapor

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

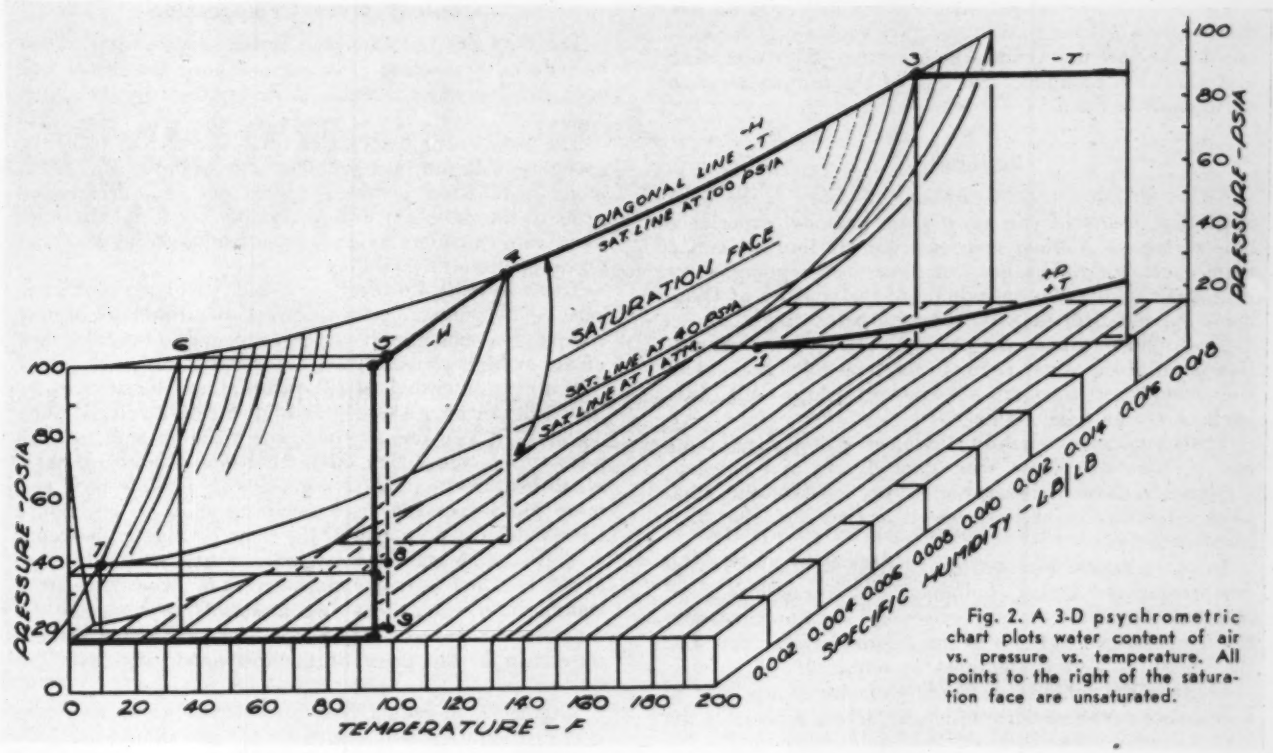


Fig. 2. A 3-D psychrometric chart plots water content of air vs. pressure vs. temperature. All points to the right of the saturation face are unsaturated.

Table 1.—Psychrometric Conditions for Points in Fig. 2

Point	Pressure (lb/sq in)	Volume (cu ft/lb air)	Temp (F)	W lb water per lb air	Relative Humidity (%)	Dew Point (F)	Vapor Pressure (lb/sq in)
1	14.7	14.03	85	0.01573	60	70	0.3631
2	100	3.21	384	0.01573	—	133.9	2.4630
3	100	2.25	133.9	0.01573	100	133.9	2.4630
4	100	2.08	95	0.00511	100	95	0.8150
5	100	2.07	95	0.00051	10	30	0.0817
6	100	1.83	30	0.00051	100	30	0.0817
7	35	4.97	6	0.00051	100	6	0.0286
8	35	5.91	95	0.00051	3.5	6	0.0286
9	14.7	14.08	95	0.00051	1.5	−12	0.0120

per pound dry air, will extend the operating temperature range (dew point) down to 30 F at 100 psia. This air can be piped anywhere and exposed to weather temperatures as low as 30 F without showing any condensation. This shows the effect of the dryer.

Dryer Operation

The adsorbent-type dryer can be adjusted to maintain dew points below 30 F. Most of the time virtually all of the water vapor is removed, and dew points of –60 F and lower are not uncommon. During the winter months, when the extremely low dew points are desired, the temperature and vapor conditions of the entering air are lower and the cooling-water temperatures also are lower. This latter condition creates a lower load for the dryer and the drying will go to lower and lower temperatures. Thus the system is somewhat self-adjusting to weather conditions.

Note that it is the last increment of drying which provides the maximum protection against condensation. Therefore, assurance of troublefree operation is attained only readily with adsorbent equipment.

Vapor near the bottom of the chart is more difficult to remove than is vapor in air at the higher dew points; this is the key to the cost of vapor removal. Where the vapor concentration is high, part of it can be removed simply with cooling water at 55 or 60 F. With lower-temperature cooling mediums, including refrigeration, additional vapor can be removed, at a somewhat increased cost. However, these cooling mediums have a limiting temperature because operation becomes complicated when the dew point drops below freezing temperature, 32 F. Systems which require dry air at lower dew points usually must resort to adsorption. Although the adsorption system has increased drying costs, this is not the total picture because the bonus of more reliable operation and less maintenance must be considered on the credit side of the ledger. In the final analysis the "cheapest" system is the system which is properly engineered to function properly and reliably with a minimum of maintenance. In many instances this requires an adsorbent dryer, properly sized to meet the load.

Cost Factors

Physically it is possible to get air dry enough by compressing high enough, cooling low enough, and then reducing the pressure low enough. However, to compress 1000 scfm of air to 100 psig requires 220 hp, with compressor efficiency of 80 percent; to compress 1000 scfm of air to 40 psig requires 120 hp, with compressor efficiency of 80 percent.

Therefore, compressing 1,000 scfm to 100 psig and expanding to 40 psig requires 100 hp. Converting hp-hours to kwh:

$$100 \text{ hp-hours} = 74.5 \text{ kwh}$$

Assuming 1 kwh costs 1.6c: operating costs are (74.5) (0.016) or $1.19/hr, or 1.98 cents per minute, or 1.98 cents per 1,000 scf of air. This does not include the amortization of the price difference of the 100 psig and 40 psig compressors. However adsorption dryers have operating costs of only tenths of a cent per 1000 scf of air dried.

The cost of operating instrument-air dryers is so low that we have not been asked to figure such a cost for anyone in the last ten years. Factors other than operating cost affect the economic selection of the proper dryer to do the job in hand.

Reliability

Above all other considerations, *reliability* is the most important. Many of you know from personal experience how serious it is when your instruments foul up and a plant shuts down. The news of a catcracker going down in a small refinery in the middle of the prairies of Oklahoma spreads over the whole county before nightfall.

Tracer lines to keep the air lines above the condensation point of the water vapor in the lines have been used. But steam tracer lines are not known for high reliability, particularly on cold nights.

The ultimate in reliability involves a dual air supply, and preparation plants with dual dryers and constant vigilance in the compressor house. Any less than this complete reliability must be assessed against the risk of a plant shut-down.

In some plants, logs are kept of the operation of the compressor and drying equipment; charts are kept of all operations to show that the valves did shift on time, that the temperatures did rise to the desired values; and that the pressures were maintained as required.

Oil from the compressor is a large factor in mucking up instrument systems. The desiccant dryer, especially the activated-alumina-type dryer, is a good separator for the removal of oil and muck from the air streams, but it is an expensive way to filter air because in time the desiccant is fouled and its capacity decreases. Therefore, filters are available containing removable desiccant-type cartridges which may be cleaned by changing the cartridges or backwashing with solvents.

There is a device available which combines an effective mechanical separator with a desiccant bed. The separator throws out the water particles, droplets, and the heavier oil entrained; the rest of the muck is picked up in the removable desiccant bed. Filters ahead of the dryers are nearly standard practice these days.

Load Factors

The load factor has a large bearing on the cost of instrument-air dryers. A dryer of the desiccant-type, fed at rates below its maximum capacity throughout 24 hours, will have a greater total capacity for water removal than that same dryer fed continuously at maximum capacity. On large jobs, particularly, it may prove economical to investigate carefully the actual load factor and specify such capacity rather than the maximum continuous capacity of the compressor equipment.

Ambient Temperature

To prevent any water in the liquid phase from reaching the instrument air lines the drying system must dry that air to a dew point below any temperature to which any part of the instrument air system will be subjected. In the temperate zone there is a marked difference in the requirements for summer and winter use. Engineers should state the outlet conditions desired for summer and winter if there is much difference.

The trend to go deeper into the polar regions is forcing more rigid specifications on the instrument-air dryer. Many refineries now have equipment to dry to zero degrees F, but the new refineries being built in Canada require air with dew points of –40 degrees F.

Cooling After Compression

The load on desiccant-type instrument-air dryers can be reduced by cooling after compression; the cooler you cool, the less water remains to be removed by the desiccant.

The use of pre-refrigeration often has proved to be the economic solution to a problem. For example, one enormous installation involved 3,000 tons of refrigeration *prior* to the desiccant dryer. This combination of equipment was considerably less expensive than all-desiccant dryer operation.

These benefits, however, occurred at atmospheric pressure. As the pressure goes up, the economics involved may change. For example, if you have to dry 1,000 cubic feet of air at high pressure, the dryer has a different job if this air is saturated at 70 rather than 40 degrees F. You will not have to have as high a tower and as much desiccant if you use a dual-tower machine with, say, 8-hour cycles rather than 16-hour cycles. There are automatic instrument-air dryers made with shallow beds and more rapid operating cycle, some as short as one hour; these machines do not show the same savings in desiccant as do the older standard machines. Furthermore, because of the fact that instrument-air dryers are now fairly well standardized, each to its own standards, a change in the moisture content of the input air may or may not make a difference in the price of the instrument-air dryer required.

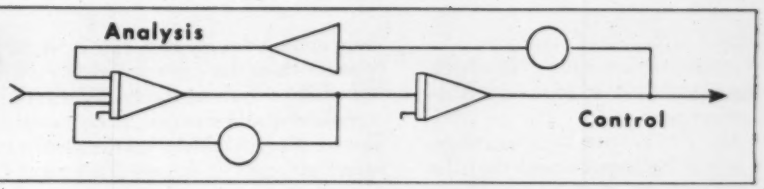
Engineers, in asking bids for systems where they suspect refrigeration will save them money, should ask bids from desiccant-dryer manufacturers in two ways: (1) Price of the dryer to handle air cooled by the cooling water available, and (2) price of the dryer to handle air cooled to the recommended refrigeration temperature, usually 40 degrees F.

There is a school of engineers who, in their desire for reliability, simply insist on static drying equipment throughout the cycle; no moving parts, they say.

Conclusions

1. If you are going to use air-operated instruments, you need an instrument-air dryer. Doing without dryers, using tracer systems, and adding anti-freeze chemicals to the air are not solutions to your problems. Industry-wide acceptance of the instrument-air dryer confirms this.
2. Above all else, insist on reliability; go as far in duplicating equipment and in safe-guards as your determination of the calculated risk of shutdown will permit.
3. Specify conditions to take advantage of any difference between summer and winter outdoor temperatures. With more and more plants being built in colder countries, be sure to specify dew points low enough to properly protect your instruments at all times. The dew point should be below the lowest temperature to which the air lines ever will be subjected.
4. If there is a difficult load factor in the use of instrument air on your particular problem, outline the conditions to give the dryer manufacturer a chance to offer you the optimum equipment for the job.
5. When you consider pre-refrigeration, remember that reducing the moisture load by refrigeration does not always result in a lower over-all cost for the drying equipment. Get prices for both methods.
6. Where oil-lubricated compressors are used, getting this oil out of the air stream is important. Ask for the proper equipment for this purpose.
7. The cost of operating instrument-air dryers is so low that it is not of practical concern today. The reliability desired largely determines the owning cost.

The SIMULATION COUNCIL Newsletter



Box 731, Camarillo, California

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Western Simulation Council

Otis L. Updike, U.S. Naval Air Missile Test Center, Pt. Mugu, Calif.; Chairman, Steering Committee.

Midwestern Simulation Council

L. M. Warshawsky, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio; Chairman, Steering Committee.

Eastern Simulation Council

Harold K. Skramstad, National Bureau of Standards, Washington, D.C.; Chairman, Steering Committee.

Bits

Well, I guess the handwriting is on the wall. Analog computers are already obsolete. The only reason we are not advised to throw them out is that most of us do not yet have access to a large general-purpose digital computer. Or so we have been told by Bob Prince.

Bob Prince has put in his two-bits' (or two-megabits') worth, and now we know. This is not sarcasm. Bob gave a very informative talk, as all who care to read the story of the Western Simulation Council meeting under *Pieces* will see. And whereas Bob did not say analog computers are no good, he made it plain that digitals are so much better—and easier to program—that except for a few piddling problems there is no use fooling with analogs*. If, after reading his story, any of you have anything to say in rebuttal, let's hear from you; after that meeting we would love to have something good to quote about analogs.

*Important aside to process men:

Mr. Prince's comments on the superiority of the digital over the analog computer stems from the complexity of the problems now facing missile designers—which are more mathematical in nature than simulatory. In the process field the majority of initial problems will be analysis via simulation—and it is the analog computer that is the true simulator. Hence your editor predicts that analog computers will find the most process applications—and that the question of the superiority of digital vs analog computers will be argued in the process field on an entirely different plane, with different problems, different factors involved and, perhaps, different conclusions.—MHA

Pieces

WESTERN SIMULATION COUNCIL MEETING (of 17 March, 1955)

Irv Culver, Systems Development Engineer, Missile Systems Division of Lockheed Aircraft Corporation, Van Nuys, California welcomed us and explained that he was a "connoisseur" rather than a worker in simulation, and would therefore talk on *what* the Lockheed people get out of simulation rather than *how* they do it.

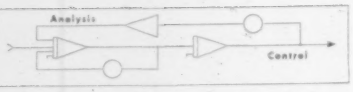
Lockheed has simulated autopilot and control systems for the past seven years, using MIT, Cal Tech, and Lockheed's own simulators. They have talked considerably about a flight table but believe it will be difficult to make a servo system which is better than the best servo system they can make! "Hope somebody can come up with a flight table that is a useful piece of machinery." Their simulation in the past has been spotty and not as much as they would like, but they are hoping for improvement so they "will know where they stand before they fly." They recognize simulation as a powerful design tool as well as a method of proving whether or not a system will work. They also believe that there are vast possibilities of using simulation to simplify missile systems and thereby achieve higher reliability.

Bob Prince on Digital vs. Analog Computers

Bob Bemer, our host, introduced Bob Prince (Mathematical Specialist in the Mathematical Analysis Department, Lockheed Aircraft Corp., Burbank, Calif.), who explained that Bob has the job we all wish we had. "The California Division of Lockheed possesses both digital and analog equipment—and a lot of engineers who know nothing about computing!" People with problems who don't know what the problems are want to put them on the computers. When the problem is interesting, Bob deals with it; when it gets to be drudgery he passes it on.

They have a network analyzer, Goodyear and Boeing analog computers, a CRC 105 digital differential analyzer, and two IBM 701's. Bob described the latter as close to the largest and fastest, and certainly the most practical, of the large-scale digital computers.

He pointed out that analog equipment handles differential equations, either implicitly or explicitly, and nothing else. Originally the problems received were simple, linear, and of small order—but soon they became more complicated and nonlinear. The Division started getting multipliers and function generators, and later on



the digital differential analyzer. "a sort of cross-breed machine" in which the operation of multiplication is much easier.

But the problems kept growing. Years ago it became evident that the time was coming when the problems would be too complex for the equipment available, so they started looking for a way to put them on the digital computer.

Bob says there are about 50 different methods in the literature, all different and every one (according to its inventor) the best. "And all of them have a list of drawbacks about yea long." So the Lockheed folk spent a lot of time devising a subroutine to allow the presentation of the problem as it would be presented to an analog machine. The scaling was not difficult because they used floating-decimal computation. Addressing those of us who have scaled analog equipment, Prince asked: "How would you like to have an amplifier with a range of about 10^{180} to 1? That luxury comes for free with our digital equipment!"

One problem which plagues people solving differential equations on both digital and analog equipment is the error of integration. "Even analogs integrate only approximately." In digital computation you increase accuracy by varying the interval at which points on the solution are obtained. They found it possible and practical to instruct the machine to pick its own interval, so that is will proceed as fast as possible without introducing too much error.

There is no limit to the number or complexity of the arbitrary functions you can put into the digital machine. And with a moderate degree of cleverness you can make these functions many-valued (for example, in an air foil having a higher lift coefficient as it approaches a stall than it has when recovering). They now have a set of standard instructions—subroutines which tell the machine how to solve sets of simultaneous differential equations with a prescribed accuracy. And the computer will proceed with as large intervals as possible within that limitation.

A Recent Problem

A recent problem involved 41 multiplications, the generation of three sines, three cosines, two inverse sines, three arbitrary functions, and nine aerodynamic coefficients which are quadratic functions of other variables. This is beyond the capacity of their analog equipment, and is slightly more than the capacity of the digital differential analyzer. Also, the complete problem (as they would like to cover it) includes the position of an airplane in space. This would require three more differential equations and nine more multiplications. In addition, they would like to make some of their aerodynamic coefficients functions of Mach number, which would require another 20 curve-followers.

For this problem it took three weeks to develop the subroutines for the 701, and another week to program the specific equation. So far there is no autopilot involved. "The autopilot would make for a really sophisticated problem," but this would be easy on their digital computer.

They are presently using approximately 1/100 of the memory of the machine (electrostatic only). This limits them to approximately 16 differential equations. But they are developing a subroutine which will handle 100 to 150 simultaneous differential equations with no limitations on the form.

Summarizing, Bob Prince said, "When a problem gets too big, too nonlinear, too messy to handle on analog equipment, it is easy to handle on digital equipment. This of course gets away from the physical simulation, but that is the penalty you pay for having such sophisticated problems."

Discussion on Prince's Talk

Opening the discussion, Otis Updike (U.S. Naval Air Missile Test Center, Pt. Mugu, Calif.) asked about 701 setup time. This was twice analog setup time, but ¾ of it was spent in devising subroutines. Would future setup time be half that of the analog?

PRINCE: That is the fundamental idea. In digital work you do not program for a particular problem, but for a class of problems.

UPDIKE: If you take the cost of digital equipment as 10 times that of analog equipment for solving the same problem, you would have to show a ten-fold saving of time to justify the use of the digital equipment.

PRINCE: That depends. In an analog machine a large part of the machine time is spent in wiring up the problem, which means physically tying up the machine so it cannot be used for other problems. On the other hand, with a general-purpose digital calculator the problem is actually contained in a deck of cards and the equivalent of wiring up the machine takes about 30 seconds. So, although a general-purpose digital machine does cost about 10 times as much, it is not tied up while you wire up the problem.

UPDIKE: A pre-patching system would partially obviate this trouble with the analog, although you cannot avoid checkout time which ties up the machine.

CULVER: You can't avoid checkout in anything.

PRINCE: It turns out to be easier to check out the digital machine. Two days were spent correcting errors in the digital routine, as discovered by the machine. The checkout involved only about 20 minutes of machine time.

Asked whether he advocated the use of digital machines on complex problems or on all problems, Prince replied that he didn't think complexity was a fair criterion. Asked if the degree of nonlinearity is a deciding factor, Prince said it would be a limiting criterion. "If you have only so many multipliers in your analog equipment and you need more, that's it!"

CULVER: I think a lot of the difficulties involved in trying to satisfy the customer are due to the customer's ignorance of the problem. Many times problems are solved which should not be solved at all, and other times problems which should be solved are not even studied. Computer people as a rule are not in a position to know which are important and which are not. I don't know the solution. Screening is bad, but it might help.

JEROME JACOBS (Hughes Aircraft Co., Culver City, Calif.): The type of operation I am associated with tends to solve the problem. There is a lot of cooperation and understanding of the problem by both the so-called programmer and the engineer in charge of the problem.

CULVER: I had in mind the type of problems which are not of value even if solved.

PRINCE: That's the reason I have a job. One of my primary functions is to screen problems. This is not a total solution, but it helps.

McLEOD (to Prince): I know little of digital computation, but I do know that in working with analog problems you can get a real "feel" for the problem. When digital equipment

is used in the conventional manner this feeling for the problem is lost. Is some feeling for the problem preserved when the digital computer is set up to solve differential equations as you have described?

PRINCE: More so than in the conventional way. It is, however, unfortunate that you do lose quite a bit of the physical feeling, largely because the solutions are longer in real time, as a rule. However, this is not necessarily so. On a digital machine it is more convenient to read out the quantities in which you are actually interested. Furthermore, if you wish to change axes it is a nightmare on analog and very easy on digital equipment.

McLEOD: Theoretically it is easy on analog equipment. Do you mean it is not easy because the equipment available is not very good?

PRINCE: You are likely to wind up with small differences of large numbers.

CULVER: You are quarreling with the capabilities of the equipment.

PRINCE: The equipment is fundamentally capable. It is simply less convenient to do it.

JACOBS: Is it not true that if you are worried about small differences of large quantities, you have exactly the same problem with a floating-point digital system?

PRINCE: In general no, because you have a large number of figures available. However, if you do run out of figures, the routine we have set up to control errors will cause the machine to pick up and start the problem again in such a way that the error is brought into permissible bounds.

JACOBS: Then you must start off using about 40 significant figures.

PRINCE: If we do the machine will quickly open up the computing interval until it is proceeding as fast as it can go and still maintain the specified accuracy. However, if we put in a step function which generates higher harmonics, the machine will immediately come to a very fine interval so that it can trace out the harmonics until they have died out. Then it will open up the interval again.

JACOBS: To what do you charge the time for punching up the cards?

PRINCE: That is done on another machine.

The agility with which Bob seemed to be ducking this one made everyone laugh, so he explained that the large-scale computer rents for about $30,000 a month whereas the one the cards are punched on rents for about $50 a month.

JACOBS: The time is involved, anyway, and corresponds somewhat to wiring up an analog computer.

PAUL BROCK (Electro-Data Corp., Pasadena, Calif.) asked about the technique by which the machine automatically determines its own interval.

PRINCE: We are using a modification of the Adams method, which uses divided differences instead of ordinary differences. This means that we expand the function in the Taylor series and truncate it at some finite order. When each new point is added to the solution, we compute one more difference than was used in predicting that new point. This is equivalent to computing one more term in the Taylor series expansion, which is a first-order approximation to the error term in the integration. This can be compared against the function which you are evaluating, together with some criterion as to how big the error may be. This keeps the truncation error within permissible bounds and also guarantees that you will stay within the circle of convergence of the Taylor series of expansion, which is very important.

If any errors are too great, they throw away the new point, go back and try again at a smaller interval. If, on the other hand, all of the truncating errors are within the prescribed limit, the new point is good, but time is being wasted, so the next point will be computed at a larger interval. Thus the computer will speed when it can, but take its time going around the sharp corners.

BROCK: Don't you find that the time is excessive?

PRINCE: No, for in smooth functions we take very large steps. For example, in one problem we wanted to know what would happen to the turboprop version of the Constellation in event an outboard engine failed and the propeller did not feather. This would suddenly put a ten-ton drag way out yonder on the wing. Prior to the application of the engine failure the computer was proceeding at about 10-second intervals. As it was computing a point about every five seconds, the computer was going in double real time. Upon application of the engine drag, the computer immediately slowed down to about 1/100-second intervals and then opened up to about 2-second intervals as the transient died out. Then the computer was going about ½ real time.

BROCK: Have you run into any problem with high frequency, low amplitude?

PRINCE: If this is of interest you could reduce the tolerable error in the questionable region.

DONN COMBELIC (Computer Control Co., U.S. Naval Air Missile Test Center, Pt. Mugu, Calif.): Apparently in each step you have asked for four-decimal digit precision. What fraction would you allow for each step of integration?

PRINCE: The majority of the problems we have solved have been numerically stable. Therefore it has been practical to specify at each step that we carry four significant figures. If you tried a problem in which the truncation error continued to grow as the solution went on, this would not be a physically interesting system. Any physically interesting system will have a numerically well-behaved solution.

COMBELIC: I got the impression that you thought your use of the floating decimal gained you so much in programming time that it more than offset the increase in computer time.

PRINCE: This question is becoming academic. The end of this year we are replacing our 701's with 704's, which are as fast with floating as fixed point. So we can relax and enjoy it!

Asked what proportion of the 701 time is spent in solving the type of aerodynamic problems which he described, Bob answered: "2 or 3 percent. The 701's are overcrowded. The 704's will help by a factor of about 10, but the amount of work is growing by a factor of 2 or 3 each year."

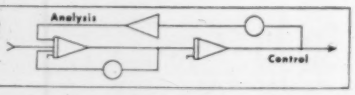
CULVER: There are a few systems of interest which are not well-behaved. Such things as the separation of a booster or Jato bottle and the path it describes are not necessarily well-behaved physical systems, yet they are of interest.

PRINCE: Yes, the initial part of this solution would be a stinker.

COMBELIC: Have you ever found it necessary to repeat a 701 solution because the 701 itself made an error?

PRINCE: Not under our particular program, because it is completely self-checking. The only problem is: Are we solving the right problem?

HANS MEISSINGER (Hughes Aircraft Co., Culver City, Calif.): To



use simulation effectively as a design tool you are faced with a search for optimum parameters. Could the digital computer be used to make automatic decisions by stepping onto the next more optimum solution? Could it be used in conjunction with an analog computer to do this?

PRINCE: So far we have not learned how to do better than to run out a ream of answers.

BEMER: If you try to have these machines make all the decisions you will find you are spending far and away too much time. The brain is a far better decision element than a computer. The trouble is, it's not accurate to very many decimal places.

W. B. YOPP (Douglas Aircraft Co., El Segundo, Calif.): How many variables can you carry in your mind? (That got a laugh!) Somebody has said that with reasonably complex variables the brain is capable of about 30.

BEMER: Give me more than 4 and I've had it !

PRINCE: Much as we would like to have it otherwise, you can run out more solutions on an analog machine than you can on a digital. But searching for an optimum combination of parameters by looking at the solutions is not easy. If you can define a set of ground rules under which you decide what an optimum is going to be, then it is entirely possible and practical to give the results of the analog solutions and these rules to the general-purpose calculator and have it find an optimum for you.

CULVER: The trouble is, even if you have a set of ground rules, as soon as you get a new concept of the problem, you've got to get a completely new set. The human brain is still the best.

PRINCE: One thing everybody here knows is that once you start using computing equipment you find, much to your dismay, that you are not doing less thinking than you used to; you are doing more. And furthermore, it's a lot harder.

UPDIKE: What ways have you found best for evaluation of the computer output by the human?

PRINCE: So far we have not progressed beyond the stage of presenting digital or graphic answers. It is theoretically possible to use the digital computer in any way that you would use any other computer.

CULVER: There is always more information developed than is used. All engineers have larger eyes than stomachs.

UPDIKE: Taking a cue from Information Theory, this may be the redundancy that is necessary for reliable information.

ARTHUR ZEICHNER (Hughes Aircraft, Culver City, Calif.): What specific objection do you have to large-scale analog computers?

PRINCE: I have an intuitive feeling that the setup and checkout time is going to grow faster than the size of the equipment. We know this is not the case with digital computers. However, if you wish to do a parameter study and your problem is well-behaved, you might belong on the analog. But problems are beginning to grow faster than the analog equipment. I can't give any clearcut rule. Three years ago I thought I could!

McLEOD: Before all analog equipment becomes obsolete (laughter) I'd like to ask one more question. You have indicated that a large part of the time saved by your method of programming the 701 stems from the fact that it is set up to solve a *class* of problems. Do you know of anyone who has looked into the possibility of setting up analog equipment to solve a class of problems?

JACK SHERMAN (Lockheed Aircraft Corp., Van Nuys, Calif.): Yes, but this was a very special type of problem and was not easily changed.

J. T. KOUBA (Lockheed Aircraft Corp., Van Nuys, Calif.): This is like the aero computer that is just coming out. You have a tremendous choice of your parameters but the forms of the equations are all prewired.

DON GREENWOOD (Lockheed Aircraft, Burbank, Calif.): The virtue of having digital and analog equipment able to solve the same problem is that they can be used together, one as the check on the other. You should have a common starting point to be sure you are solving the same problem, but the divergence from this point on to the end result is helpful. Internal checks in digital computers do not preclude fouling up somehow on the input, which is difficult to check on large problems.

COMBELIC asked about coded checks, such as Bob described, versus built-in checks, as in the Raydac.

PRINCE: We have two checks. First we do all of our computation twice and compare results before accepting either of them. Then we work with a difference method which means that any error escaping the first check will turn out as a higher-order difference which is out of bounds. This will cause the machine to go back and do the computation over.

BEMER: My experience has been that on a machine without self-checking you get more "up time" than you do with the self-checking ones. Shall we start the tour?

Business Meeting

In a short business session it was decided to hold the next meeting on Thursday, May 12th.

Otis suggested the following topics for discussion at the May meeting: operational amplifiers, noise and statistical problems, recording equipment, partial differential equations, readout equipment, measurement of small angles, stabilization techniques, computer systems analysis, calculations of variations, high-speed servo systems, uses of computers in industry (non-aircraft), operation of large computer installations, equipment specifications, unusual applications, simulation of humans in the loop, and computers for system optimization. This last (suggested by Yopp) received by far the largest number of votes, so was selected as the subject for the May program. Computer systems analysis came next, with partial differential equations third.

The location of the May meeting will be announced after we let the prospective host know!

Tour of Lockheed MSD

The tour of the Lockheed Missile Systems Division plant was unusually interesting. They first showed us equipment for preparing telemetered information for the computers. Very important and, as far as your Editor knows, novel feature was the use of a timing signal recorded on the tape with the telemetered data to trigger the digitizer so that effects of tape wow and flutter are negated.

A spectacular demonstration that enhanced the visit was the use of one of their FM telemeter transmitters to drive several three-inch nails all the way into a hard oak block while the output was being monitored on a scope. Some thought they saw a slight amplitude transient, but there was definitely no discernible phase-shift!

After the tour we returned to our meeting place to find a feast laid out for us! Suzy and I had planned a steak dinner, but the Lockheed smorgasbord was so good we had our meal there. Thank you, LMSD!

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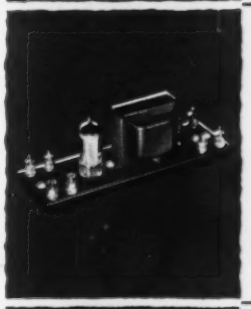

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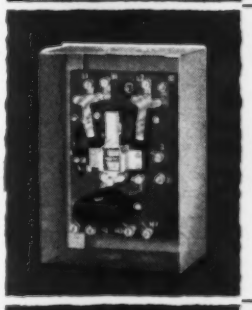

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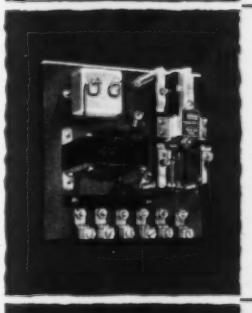

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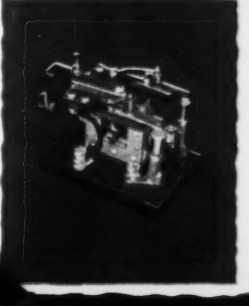
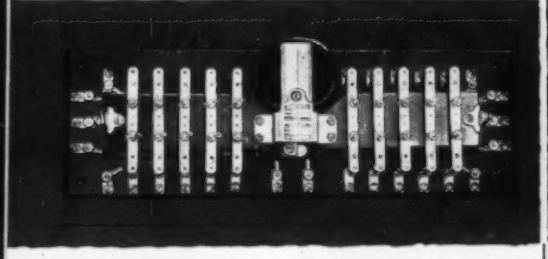
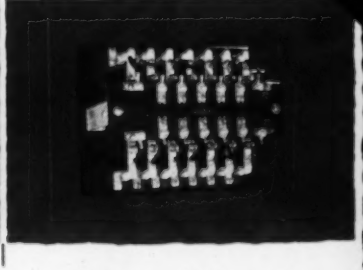


Current Relays — "Coil-less" type, designed to function like a current transformer. Load cable through relay provides magnetic field for relay operation.



Many application requirements are met and surpassed with standard ASCO Magnetically Held Relays. For example, the Bulletin 1055 Relay adapts readily to such specialized control applications as control circuit transfer relays and mechanically interlocked relays for reversing motors.



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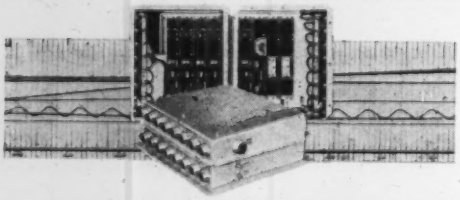

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Journal of the S C M A . . .

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LEVEL CONTROL

Proper selection of level controllers requires knowledge of principles, operation, and available designs of various equipments. Here is a clear and thorough résumé of float-actuated and displacement-type level controllers.

ARTHUR E. FLEMING
Carter-Jones Company

MANY FACTORS enter into the proper selection of a fluid level controller, including the properties of the fluid to be controlled, materials available to manufacture the controller, accessibility for service, degree of shut-off required, reservoir capacity, possibility of coking or freezing, pressure and pressure drop, and the distance between controller and valve. This article describes some of the devices that are available and the principles on which they operate.

DIRECT-ACTING LEVEL CONTROLLERS

Ball-Float Valves

For maintaining the level of liquids in open vessels, a float-operated lever-valve is used commonly to control the flow rate either to or from the vessel. One style is the double-port valve body (Fig. 1).

As this has a semi-balanced inner valve, minimum power is required to operate it. However, the power obtainable from the float and level assembly is limited. Where the flow rate and pressure is low, it is possible to use a small single-port valve; small single-port float valves are used often as a pilot valve to operate large diaphragm control valves.

A throttling-style inner valve, such as the V-port, is used generally to give proportional action over the desired control range. Size 6-inch floats are used on small valves of ½- and ¾-inch size; 8-inch floats for 1- to 3-inch valves; and 10-inch floats on larger valves. On high pressure-drops or on liquids of low specific-gravity (where the buoyant force of the float is decreased) larger floats are necessary. More power to operate the valve also could be obtained by lengthening the lever arm, but there is a point beyond which this is impractical. Also, the longer the float arm, the greater the level change necessary to produce a unit change in inner-valve position. The same general construction is used whether the valve is controlling the inlet or discharge flow. The only change necessary is to reverse the yoke, which inter-changes the position of the pivot points on the stem and swing-link.

With double-port construction, tight shut-off is not assured. On applications where some flow is required at all times, the double-port body is adequate and recommended. However, if a float valve is used to control the water storage level on top of a building, there undoubtedly would be periods of time when no flow is required and the tank level would increase and overflow. An overflow drain off could be provided, but the owner might object to paying for water he doesn't use. Therefore, a single-seated valve is required, but if a conventional single-port body were used, sufficient power could not be obtained from the float to operate the valve against the inlet pressure. To overcome this, the internal-pilot-operated float valve was introduced.

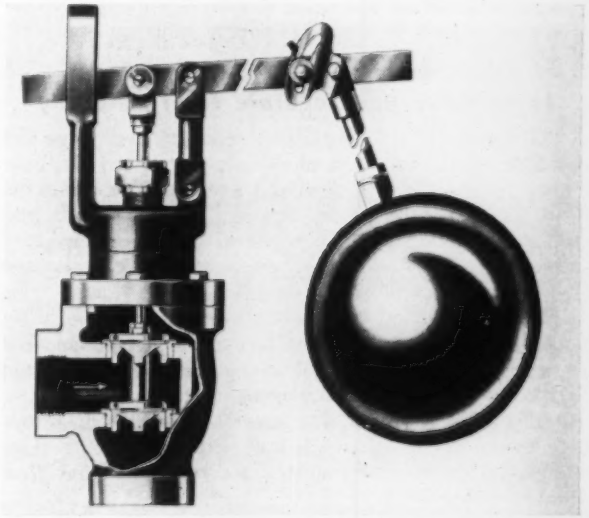

Fig. 1. Float and lever-operated valve with double-port valve body. Balanced inner valve requires minimum power, but tight shut off can not be obtained. This system is for level control of open vessels.

June Meeting: *Thursday, the 16th, Rio Hondo Country Club, Downey, Calif.*
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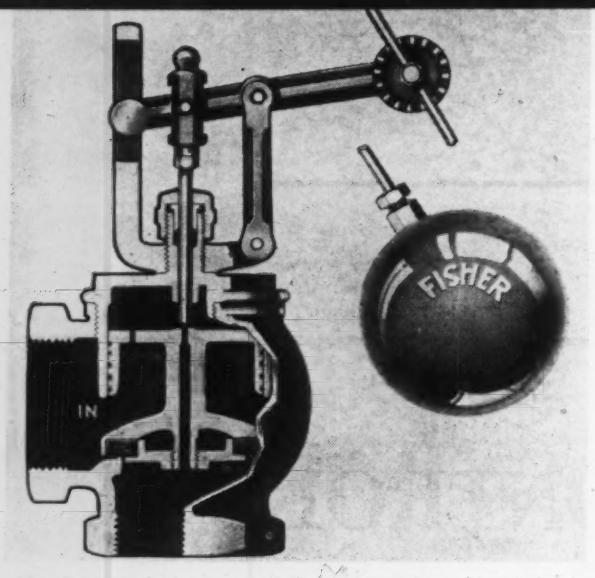

Fig. 2. Internal-pilot-operated float valve with single-seated valve and balancing piston. Valve stem controls flow through a vent hole through inner valve. Pressure drop across valve is force that moves the piston.

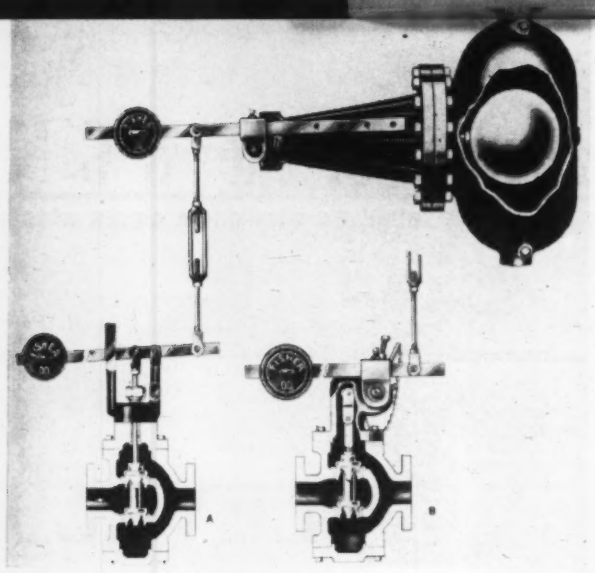

Fig. 3. Float in external cage operating a sliding-stem valve (A) or rotary-stem valve (B). Latter has less friction.

Internal-pilot-operated Float Valve

This is primarily a single-seated valve with a balancing piston on the upper end of the valve post (Fig. 2). The valve stem, instead of being rigidly attached to the inner valve, acts as a pilot valve controlling the flow across a vent hole through the inner valve. A smaller hole is drilled through the balancing piston to introduce pressure on top. As the piston area is greater than the port area, the inlet pressure pushes the piston and valve assembly upward to a position dictated by the stem. When the stem is lowered, the pilot orifice is closed, pressure equalizes across the piston, and the inlet pressure closes the valve. This construction utilizes a composition seat for positive shut-off, but is limited to the temperature that the composition can withstand, usually 150 deg F. Other designs have metal seats. Some have the piston and port areas equal, in which event the force to move the balanced valve comes from the float and lever assembly and not from the pressure drop across the valve.

The main disadvantage to this construction is that foreign materials such as pipe scale or sand can get in behind the piston, causing it to stick. A limit of about 200-psi drop across the valve is recommended. A 10-psi minimum drop is necessary to supply sufficient operating force.

Lever Valve and Separate Float Assembly

This group (Fig. 3) consists of separate lever valve and ball-float mechanisms, mechanically connected by linkage or turnbuckle. The float rod and float are connected to the lever of the valve through a rotary-shaft and stuffing-box assembly. This mode of control is necessary where the tank is closed or where the valve is located well below the level of the liquid.

The ball float and stuffing-box assembly may be introduced directly into the vessel through a flanged opening or they may be housed in a float cage externally connected to the vessel. Many advantages are gained by use of separate lever valve and float assembly, but the disadvantage is the increased number of frictional points. Two stuffing boxes are now required and two additional pivot points are added.

Use of External Float Cage

A tank stuffing box is threaded into the vessel wall (Fig. 3) through which a shaft rotates. The float rod is connected at right angles to the internal end of the shaft and a lever is connected externally. The lever of this unit is connected by means of a turnbuckle to the valve lever, as in Fig. 3. These tank controllers are used in tanks, towers, heating units and evaporators where it is not practical to have the float in the vessel. They are available with either flanged or screwed equalizing connections, and in 125- and 250-psi iron as well as 600- and 1500-psi steel rating. The most common float size is 8-inch, although the 10-inch often is used to operate larger valves or when working with lighter fluids; the latter produces 60 to 70 percent more operating power. The 6-inch float is not used much.

Fig. 3 also shows a valve with a rotary stem similar to the rotary stem on the float cage. The rotary stem is slightly more efficient than the sliding stem because packing maintenance is easier and there is less friction. As portions of a sliding stem are sometimes exposed and sometimes within the packing, extra care must be taken to keep from pitting the stem in a corrosive atmosphere, or scoring from a mis-applied pipe wrench or painter's brush.

Use of Flanged Opening

Another common installation is where the float is introduced into the vessel through a flanged opening (Fig. 4). Suggested applications of the flange-mounted construction are on vacuum towers, oil and gas separators, and on fractionating columns. This construction is preferable on heavy viscous fluids because a lag in level change would occur if an external cage were used. On some high-pressure applications, say 1500 psig, chilling could occur in an external cage if the ambient temperature dropped; hydrate formation could then possibly solidify the cage fluid. On high-temperature application, coking is a possibility; coking would be easier dealt with on the flange-mounted unit.

Where severe turbulent action exists or where foaming on the level surface may occur in the vessel, the external cage is preferred.

Fig. 5 shows the construction of the rotary-stem stuffing box.

PILOT-OPERATED CONTROLLERS

Ball-float Type

On many applications involving large valves, high pressure drops, friction, necessity for tight shut-off, etc., suf-

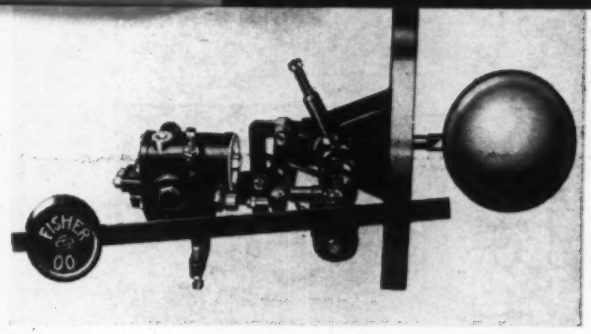

Fig. 4. Flange for introducing float directly into vessel. Shaft can be connected to pilot (as shown) or directly to a lever valve or rotary-stem valve.

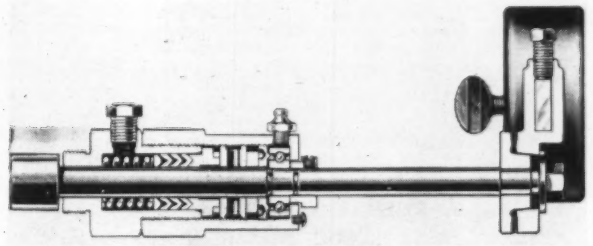

Fig. 5. Rotary-stem stuffing box. Cooling fin is recommended for temperatures above 450 deg F. or below 0 deg F.

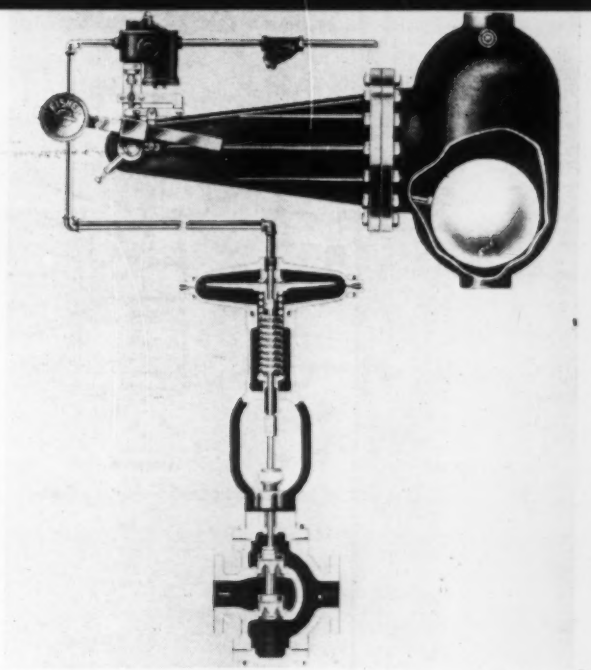

Fig. 6. Float in external cage operates pilot relay, which in turn operates diaphragm-type throttling valve.

ficient power is not produced by the measuring element to operate the valve. It becomes necessary to employ another source of power to operate the valve. The measuring element merely has to produce a small change in the pilot, which produce an amplified output. Besides gaining a large increase in power to operate the valve, the valve may be located remotely from the pilot by several hundred feet.

The designs shown for operating a lever valve can be used to operate a pilot, which in turn controls a diaphragm control valve (Fig. 6). The liquid level change is converted to a pressure change, (3 to 15 psig) which provides a positive movement of the valve. Greater stability is realized and any forces produced by the velocity of flow through the valve or by friction will not be transmitted back to the measuring element because there is no mechanical connection. The valve can not influence the float position, as can happen on direct-connected devices.

Fig. 7 shows a float and stuffing-box design especially for a pilot. This stuffing box is flanged and has radiating fins for high temperature. The rotary shaft is 1⅛ inch in diameter so that outside force can be applied to the lever without danger of shearing the shaft. This construction is used on tarry bottoms so outside force can be exerted to free it when coking occurs.

Fig. 8 shows a screw-type stuffing-box construction for pilot operation.

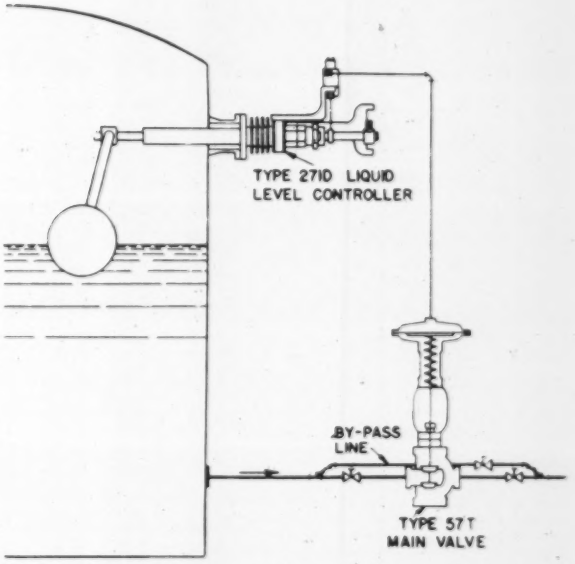

Fig. 7. Float-pilot-diaphragm-valve system for high-power applications. Rotary shaft has 1⅛-inch diameter so outside force can be applied if coking occurs and freezes float.

Pilot Relay

With full throttling or straight proportional control, the pilot (Fig. 9) transformers each position of level into a corresponding control valve position. It operates equally well on clean water or on air or gas which is supplied at 20 to 75 psig. The pilot stem is connected through a linkage system to the rotary shaft of the measuring element. Thus the rotary motion is transformed into a linear motion. As the pilot stem (85) rises, the inlet valve (97) opens and the bleed valve (87) closes, causing a pressure build-up within the pilot. This pressure acts on the bellows assembly, causing the rocker arm to close the inlet valve and limit the pressure build-up so that it is proportional to the stem travel. During periods when no stem motion occurs, both supply and bleed ports are closed. The pilot exhausts only when the output pressure

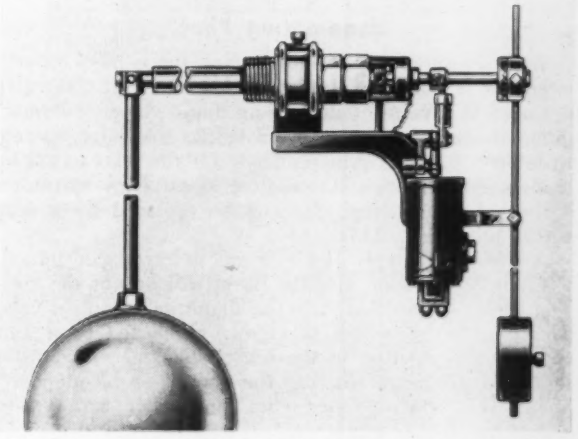

Fig. 8. Screw-type stuffing box for connecting float to pilot.

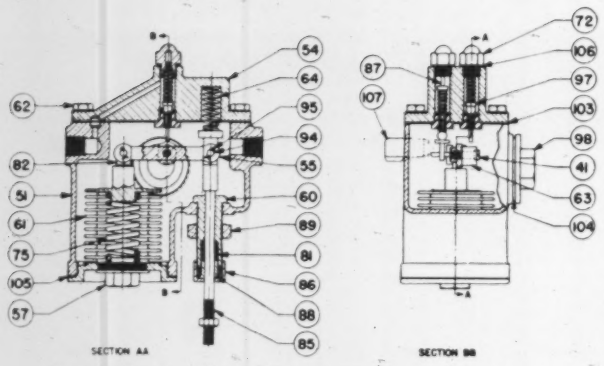

Fig. 9. Construction of pilot for proportional control.

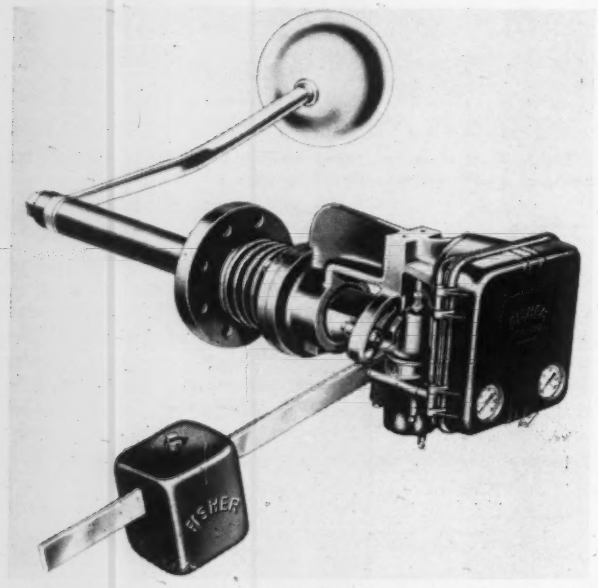

Fig. 10. Heavy-duty flanged-stuffing-box rotary-shaft unit connected to a new-design pilot featuring simple, accurate adjustment of proportional band, specific gravity, and level.

is decreasing. Reverse action requires only a simple change in the linkage. Fig. 4 shows this same pilot on the flange-mounted internal-float controller.

Fig. 10 shows the flanged-box rotary-shaft heavy-duty unit with a newer design pilot on which the proportional band, specific gravity, and level adjustments can be made simply and accurately.

Snap-acting Pilot

With on-off or 2-position control, the control valve is either wide open or completely closed. Single-seat valves are used to give tight shut-off on dump valves, automatic pump starters, and shut-off valves. As the valve operates wide open, there is little tendency for the seats to cut out or wire draw. On all ball-float controllers mentioned earlier, the throttling pilot can be replaced by a snap-acting pilot (Fig. 11).

A regulated supply of air or gas is introduced into the left-hand connection and the bleed will be out the right. The center connection is to the diaphragm control valve. The pilot lever, which is rigidly connected to a cam, controls the position of the rocker arm assembly, which in turn determines whether the supply or bleed port is open. This sharp-pointed cam and roller arrangement allows the rocker arm only two possible positions, hence no throttling. The snapping range is adjusted by means

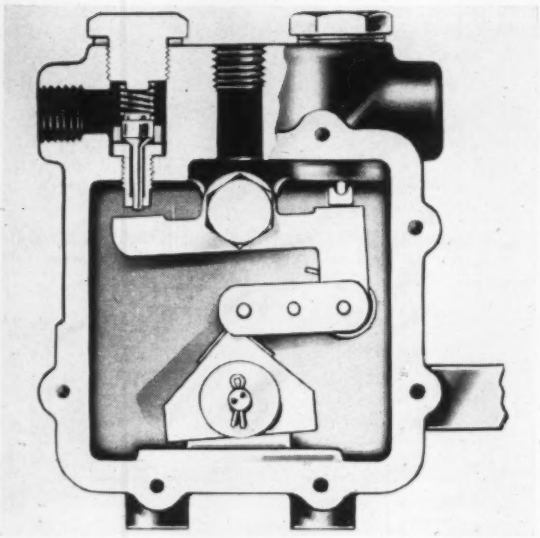

Fig. 11. Snap-acting pilot for on-off level control.

of the linkage or turnbuckle. Reversing the pilot action is accomplished simply by inter-changing the supply and bleed connections.

DISPLACEMENT-TYPE CONTROLLERS

Today's complex processes requiring close control have led to the displacement-type level controller, which can measure the slightest level change and transmit a controlling impulse to the diaphragm control valve with no determinable friction loss. The problem of friction and lost motion, inherent in the ball-float or buoyancy-type controller, is eliminated.

The cylindrical float or displacer of the displacement unit is weighted so that it sinks in the fluid to be measured, whereas the ball float rides on the level surface. A body immersed in a fluid loses weight equal to the weight of the displaced fluid (Archimedes' principle). It is this principle on which the displacement-type level controller operates.

Torque-tube Assembly

The heart of the measuring element is the torque-tube assembly (Fig. 12).

The torque tube consists of a hollow tube (E) through which a solid rotary shaft (F) is inserted. Both are welded at one end to a socket (D). At the other end, a notched collar is welded on to the hollow tube, which when inserted in the torque tube arm, keeps that end fixed. This same end of the rotary shaft is free to turn and extends into the pilot. A float rod (B) is joined at right angles to the socket. If a weight is hung from the free end of the float rod, it will be deflected downward, and socket (D) will rotate, as will the entire rotary shaft. However, as the torque tube rotates at the free end, it is held rigidly at the collar end, causing the tube to twist. A heavier weight causes a greater deflection and a greater twist in the torque tube. The torque tube is, therefore, the "spring" which measures the weight. Now replace the weight with a weighted cylindrical displacer, or "float." With no fluid around the float, the maximum torque is applied, the float is at its lowest point, and the rotary shaft produces its maximum rotation. As the fluid level rises around the float, it is buoyed up by a force equal to the displaced fluid, which causes the torque tube to untwist proportionally and produces a corresponding

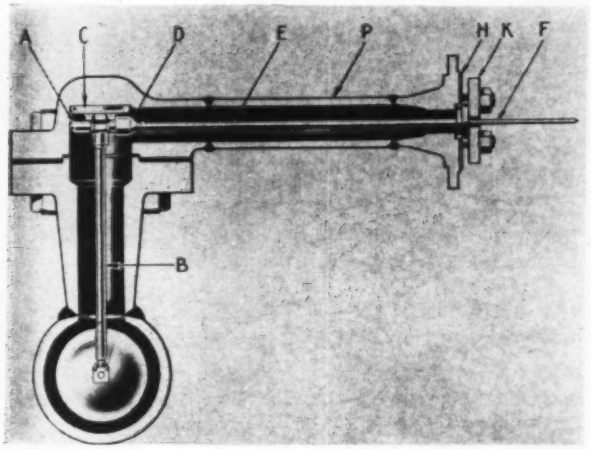

Fig. 12. Top view of torque-tube assembly, the heart of displacement-type level controllers. Buoyant forces from cylinder exert torque at end of rod B, which twists socket D. The torque tube consists of solid rod F in hollow shaft E, both of which are welded to socket D. As socket D is twisted, hollow rod E twists, but rotary shaft F rotates and is connected externally to pilot. No stuffing box is required.

rotation of the rotary shaft. Changes in level as small as 0.005 inch create a measurable air pressure change capable of producing a change in the valve position, with no stuffing-box friction.

The standard torque tube material is K Monel, which has excellent spring qualities as well as being corrosion resistant to most fluids; 316 SS torque tubes are used for applications involving oxidizing or sulfidizing. Above temperatures of 650 F, Inconel is recommended.

Displacers are normally of 304 SS, but may be furnished in practically any material, even glass. The most common displacer length is 14 inches, and 3-inch diameter, giving a volume displacement of 100 cubic inches. Float lengths up to 10 feet are standard, but longer lengths up to 50 feet have been furnished. As the length increases, the diameter decreases so as to maintain the 100 cubic inch volume which covers specific gravity ranges of 0.2 to 1.2. For interface control, with a difference in specific gravity of less than 0.2 between the two liquids, floats of greater displacement are used.

Pilot for Displacement Controllers

The rotary shaft from the torque tube extends into the pilot case and a flapper is attached to its end (Fig. 13).

A filtered supply of air or gas is regulated at 20 psig and is sent to orifice (J) and into the relay diaphragm chamber (L), through the small tubing (D)—which is placed inside the compensating Bourdon tube (C)—and then to nozzle (A). When this nozzle is not against flapper (B), no air pressure is built up in chamber (L) as nozzle (A) is larger than the primary orifice (J). When nozzle (A) is restricted by the flapper, due to a change in liquid level, pressure is built up in chamber (L), the double diaphragm assembly is pushed down, opening inlet valve (O). Supply pressure then enters chamber (N) until the relay diaphragm assembly is pushed back to its original position. Pressure in chamber (N) is transmitted to the diaphragm of the control valve. It is also sent to the proportional band portion of the pilot which consists of a 3-way valve (H) and the compensating tube (C). When valve (H) is seated against port (G), all of the air output pressure is transmitted to Bourdon tube (C), which causes it to back away, and the flapper has to move a relatively large distance to close the nozzle. If the valve is seated against port (G), no pressure is transmitted to the Bourdon tube and only a small

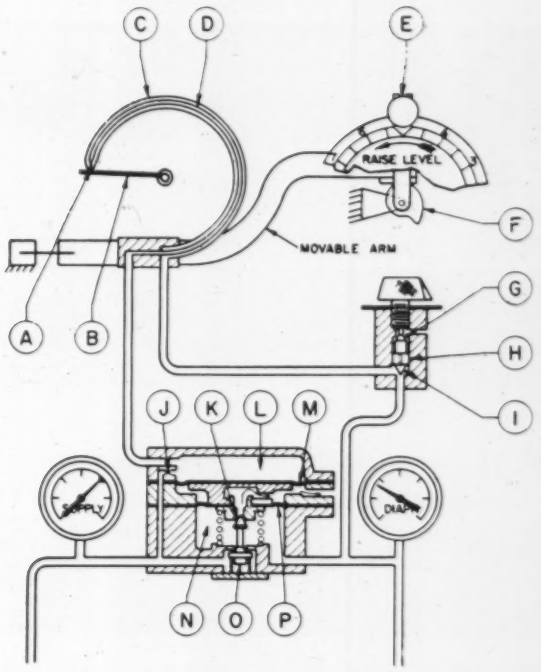

Fig. 13. One type of pilot for a displacement-type controller. Flapper B, connected to end of torque tube, covers nozzle A at end of Bourdon C. Air pressure within nozzle actuates pilot relay (J-P) in conventional manner. Output of pilot (diaphragm valve pressure) also goes to Bourdon tube via 3-way valve H, and moves Bourdon away from flapper. Hence flapper must move further. Opening valve H thus increases proportional band.

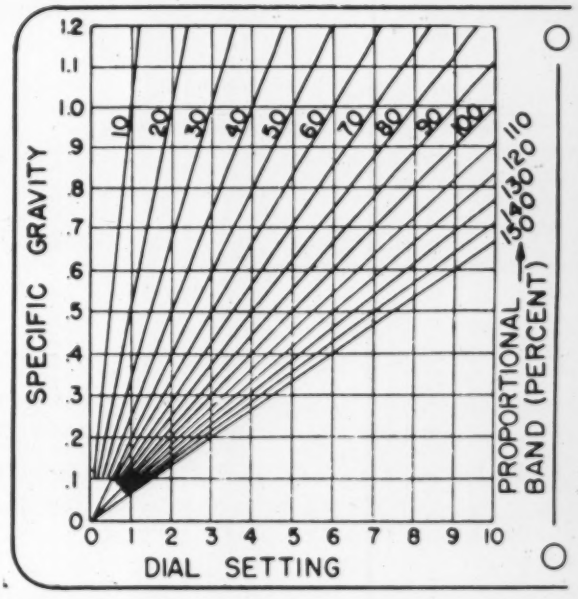

Fig. 14. Chart for setting the knob for proportional band and specific gravity.

movement of the flapper will close the nozzle. Hence opening of port (G) determines the proportional band.

The proportional band of a level controller is the amount of level change required to stroke the valve. The *percent proportional band* is the ratio of the proportional band to the float length. If a 7-inch change in level on a 14-inch float causes the valve to move from open to closed, or vice versa, the controller has a 50-percent band.

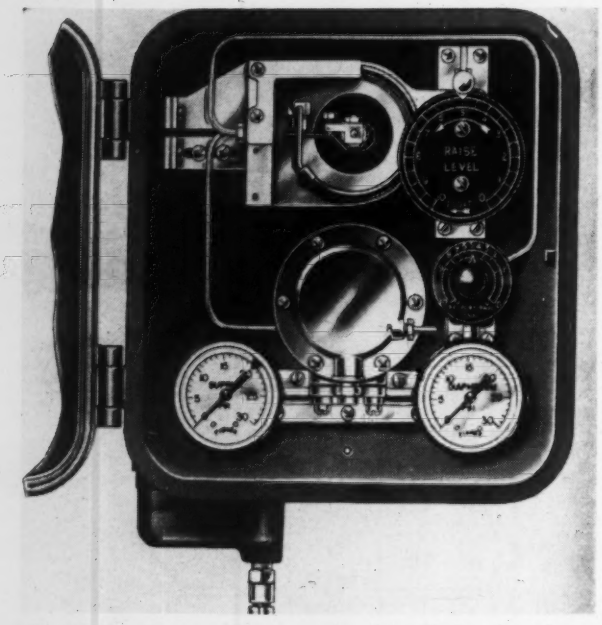

Fig. 15. Bourdon-type flapper-nozzle pilot with Bourdon-tube extension to opposite side of flapper. This provides 2-position control. Proportional band is now called snapping range.

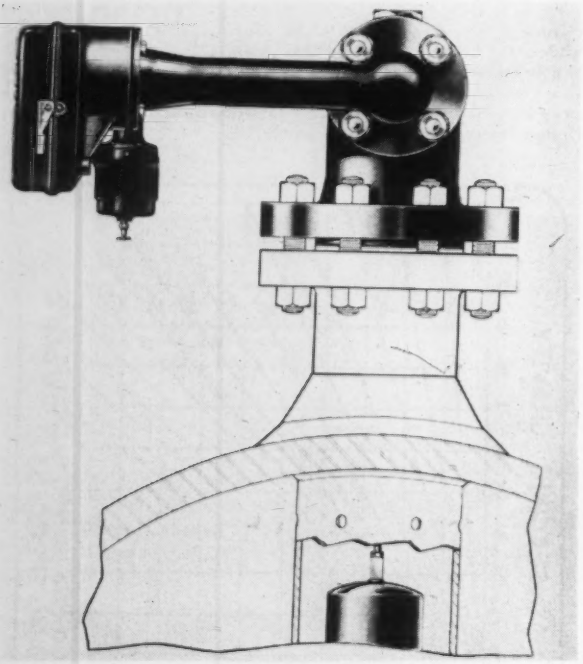

Fig. 16. Internal float design for use where external float cage can not be used, featuring insertion of float from top.

The proportional band adjustment knob is graduated from 0 to 10, rather than 0 to 100. Both proportional band and specific gravity are set on the same knob. Fig. 14 shows a chart used to determine the composite knob setting.

The Bourdon-tube assembly is mounted on a movable arm, so by changing the position of the level set adjustment, the relative position of the flapper and the nozzle is changed, which produces a change in the controlled level position. The controller action is reversed by turning over the Bourdon tube and the flapper.

Fig. 15 shows the same pilot except that the Bourdon tube has an extension which reaches around and places

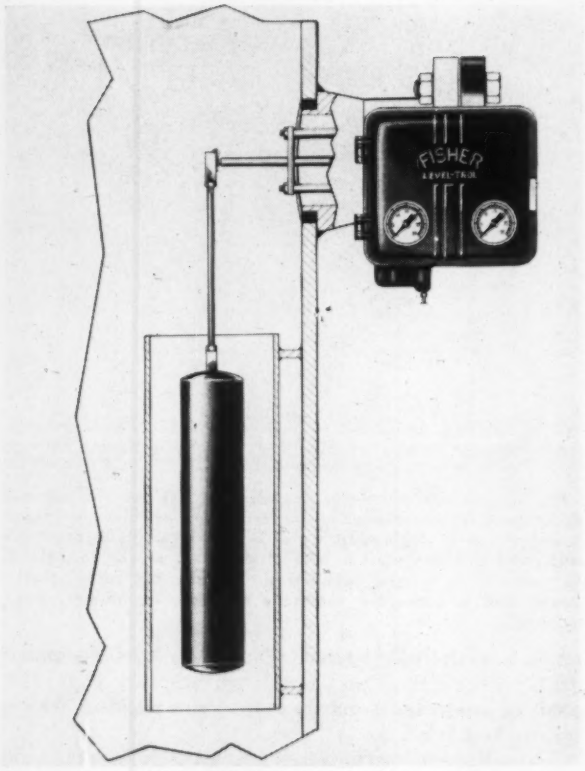

Fig. 17. Internal float design for side mounting.

the nozzle on the opposite side of the flapper, which produces snap action for two-position control. All adjustments are the same except that the proportional band is now called *snapping range.*

Types of Displacement Controller Designs

Many installation designs are available, placing the float inside or outside (in a cage), for pressure ratings of 125 to 2500 psig.

Fig. 16 shows an internal float design where the float is admitted through a top flanged connection. Internal types are recommended for controlling liquids at extremely high or low temperatures that can not be allowed to flow through a float cage; on specific-gravity control or interface-control requiring oversized floats, this construction is used often. It is used also on high-melting-point liquids that would solidify in an external cage.

Fig. 17 shows a side-mounted internal float which is used where some obstruction above the level makes it impractical to drop the float down from the top. This construction is particularly adapted to oil and gas separators.

Fig. 18 shows the most popular construction—top and bottom screwed equalizing connections on an external cage. The same construction is available with flanged connections, on the top, bottom, side, or in various combinations.

It is possible to make use of a flanged side-side design where space limitations occur. If possible, it should be avoided because other designs allow for some piping tolerances, but with the side-side flanged connections special care must be taken by the tank fabricator to keep the two flanges exactly in the same plane.

Use of Remote Receiver-controller

At times it is desired to control with a proportional band setting less than 100 percent and also to indicate the liquid level on a remote receiver gage. To do this, a receiver-controller and receiver gage is added (Fig. 19).

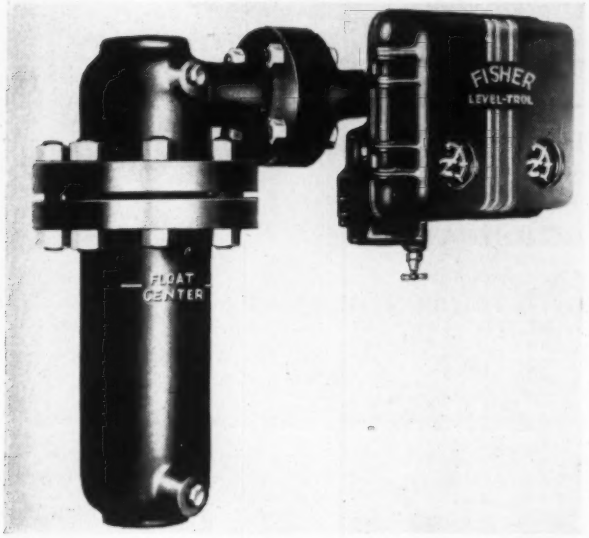

Fig. 18. External cage with top and bottom screw-type connections is most popular design. Cage is also available with flanged connections, side-side, top-side, etc.

The level controller at the tank is set for 100-percent proportional band; this air goes to the receiver gage for level indication. This same air is piped to the receiver-controller, which operates the diaphragm control valve at the desired proportional band setting as set on the remote receiver-controller.

Reset action is often introduced in the receiver-controller to compensate for flow rate. With proportional control, for every flow rate through the valve there is a corresponding level position. However, with reset action added, if the process demands a higher or lower flow rate, the valve will assume a new position that is not tied down to the level deviation.

OTHER TYPES OF LEVEL CONTROL

Bubbler System

On some applications it may not be possible to use a float-type controller, as in corrosive services. If it is an open tank, the air bubbler system can control the level.

A pipe, or dip tube, is lowered into the vessel and a constant air-supply pressure is introduced through a restriction orifice. Generally, a combination sight-feed bubbler and needle valve is used as the restricting device, which also shows if air flow is taking place. The air-pressure downstream of the restriction is piped to a pressure controller that contains a low-pressure element, usually a bellows or a diaphragm. Only the dip tube need be of corrosion-resistant material. The supply air pressure must be higher than the head of the liquid so that at high levels the pressure will build up and still escape from the bottom of the tube. As this air is allowed to escape, the pressure in the control line will build up and always be equal to the liquid head. This system has proved practical in the film processing industry and others.

Altitude Valve

This is one of the many varieties of diaphragm-type level controllers in which the head of the liquid is transmitted to a diaphragm and opposed by a spring. Fig. 20 shows an altitude valve controlling the input to a storage tank. A diaphragm control valve is installed in the main line, and a small-single-port diaphragm valve serves as a pilot. Hydrostatic power to operate the valve is piped from

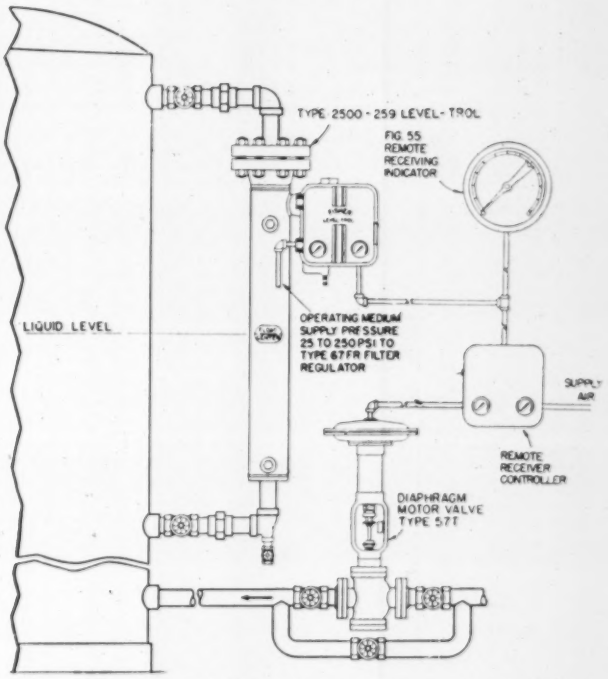

Fig. 19. Receiver-controller and gage for remote indication of liquid level and remote setting of proportional band. Controller at tank acts as transmitter. Remote controller controls final control valve.

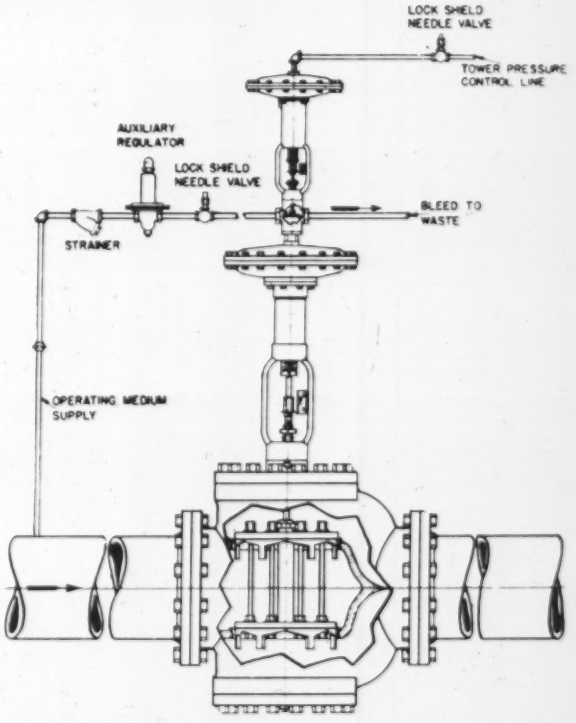

Fig. 20. Altitude valve uses tower or tank pressure to operate small diaphragm valve, which in turn controls pilot valve that controls air pressure to large control valve in main flow line.

upstream of the main valve and regulated to 20 psi, and then to the pilot valve body via a small restriction orifice. Here again is the same pilot set-up described earlier—that is, a small primary orifice and a larger secondary variable-orifice to control the pressure to the diaphragm of the main valve. The bleed is controlled by the head of liquid on the pilot-valve diaphragm.

Briefs . . .

INSTRUMENTS and AUTOMATION

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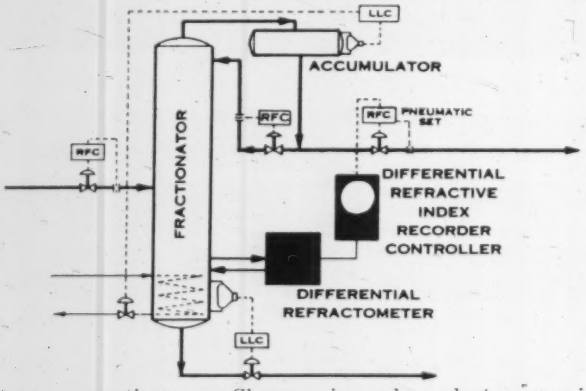
Differential Refractometer

Refractive index is a measure of the velocity of light through the test fluid as compared to its velocity in vacuum . . . composition analysis by refractive index techniques can be used in many more applications than is at first apparent.

The Phillips 66 Differential Refractometer is particularly effective as a control instrument for fractionating



tower operation. . . . Changes in end product composition are usually accompanied by sizeable changes in R.I. in the optimum sample zone. The Differential Refractometer measures continuously and records any difference in the R.I. between the *actual* composition and the *desired* composition at the sample point.

Automatic control of the column can be established through completion of a feed-back loop. A typical control system is shown where deviations from the selected R.I. at the sample point actuate a pneumatic controller which, in turn, varies the set point of a rate-of-flow controller in the overhead takeoff line. The remaining link in the feed-back loop consists of a liquid level control on the overhead accumulator which determines the quantity of heat input to the system. (*From new 8-page Brochure "Fractionator, Blending, and Quality Control," Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.*)

For this literature circle **501** on inquiry card.

Inductive Process Control

The firm of Schoppe & Faeser G.m.b.H., a subsidiary company of Messrs. Hartmann & Braun AG., has developed a new electronic regulating and control method

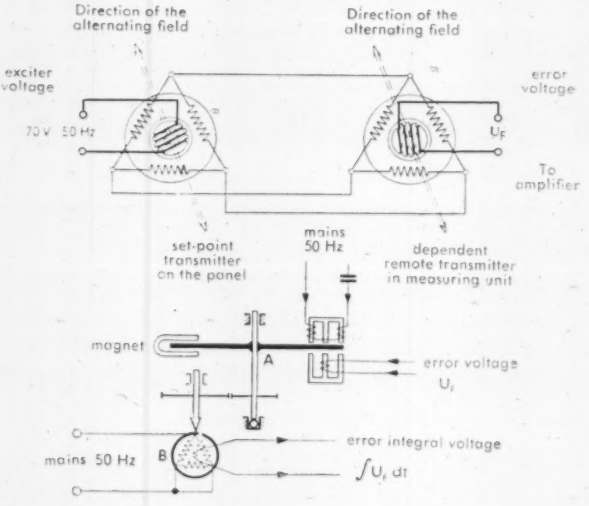
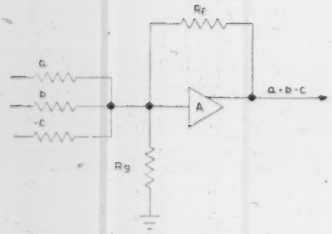


Fig. 19: T-unit

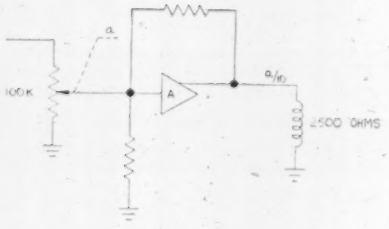
based on use of electronic amplifiers and inductive tapping and is therefore also referred to as "inductive control". This method is the answer to the need for a continuous acting all-electric rapid control.

The fundamental principle of automatic inductive control is the following: The measured value (of the controlled condition) together with the inductive remote transmitter is "reflected" as an electric potential, then amplified and finally transferred to the servomotor which, over the regulated condition, connects up with the controlled plant. The controller is generally constructed of three main recurring units: 1. inductive remote transmitter without contact (magslip); 2. electronic control amplifier; 3. low-inertia induction motor without contact. For certain problems a T-unit is used to give the automatic controller a defined

Operational Amplifier



Summing



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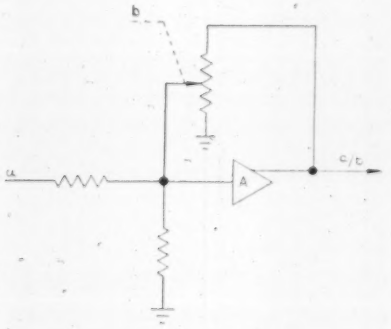
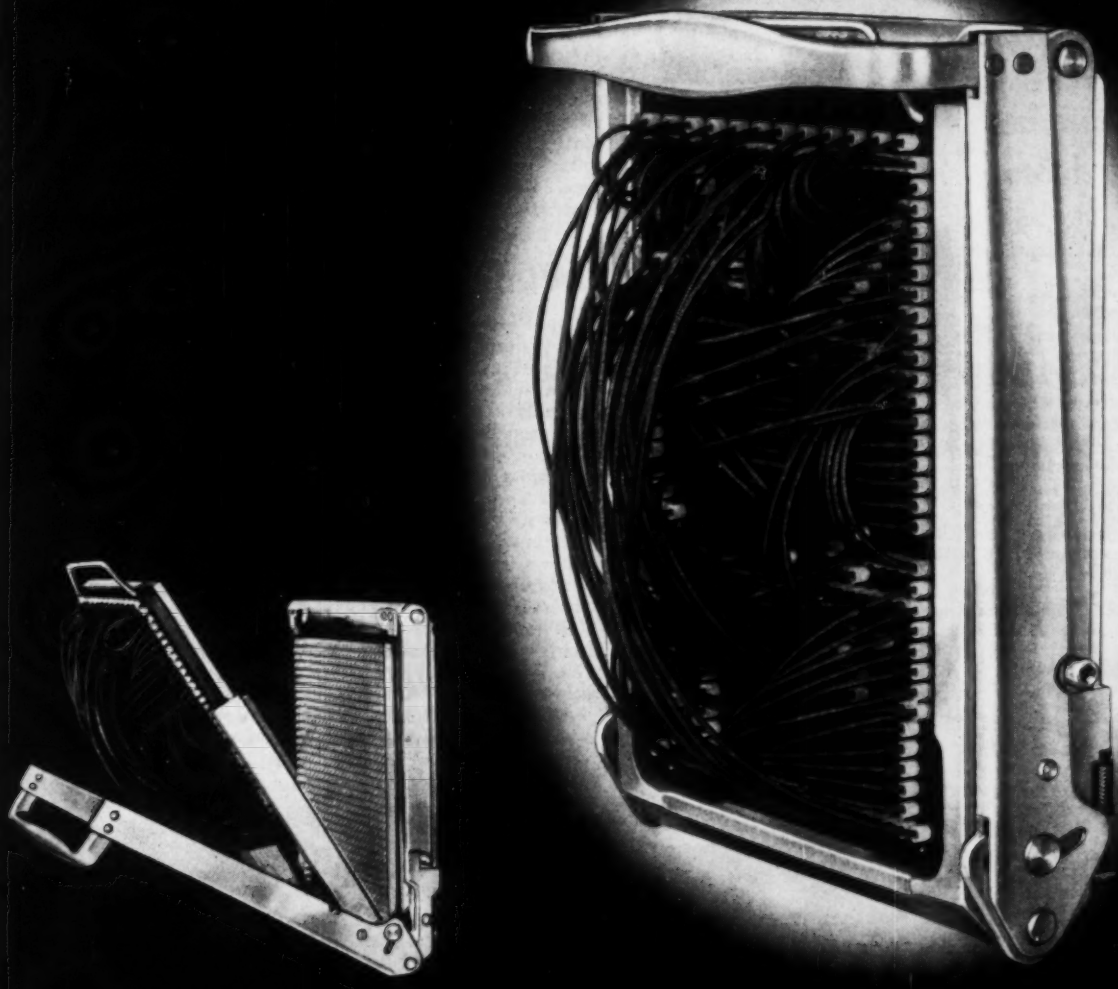


Division—Multiplication

The Universal Operational Amplifier Model 200-B is a flexible computer component. A few of the many applications are outlined.

Specifications: Carrier frequency—60 or 400 cps; input impedance—2 megohms; open-loop gain—20 x 10^3; noise level—less than 0.1 x 10^{-3} v. (*From new Brochure FC1 containing six 4-page brochures on servo amplifiers, etc., Feedback Controls, Inc., 1332 N. Henry St., Alexandria, Va.*)

For this literature circle **502** on inquiry card.



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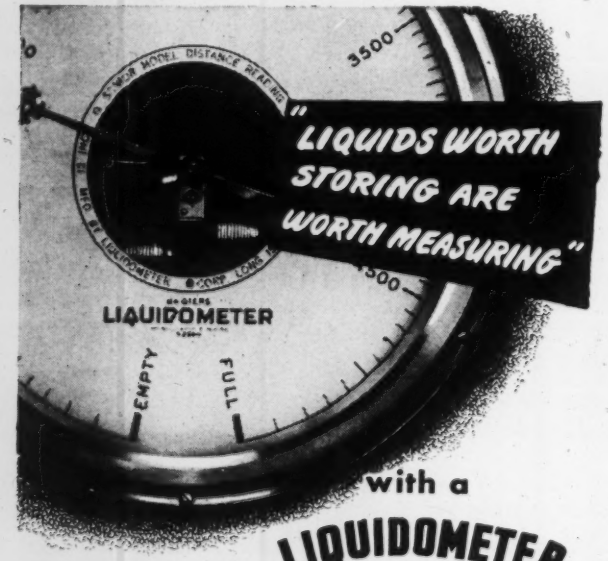

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BRIEFS—CONTINUED

transient response. It consists mainly of an inductive remote transmitter and an induction motor (disc-type) used for many years in electrical recorders, which adjusts the rotor of the inductive remote transmitter over a speed reducing drive (1:100 or 1:1000). According to the electrical connection of these two units and other units of the automatic controller, the T-unit functions as a. integral action unit; b. delayed follower unit; c. derivative unit. (*From new 54-page Booklet* 789, *Hartmann & Braun AG, Frankfurt/Main, Germany.*)

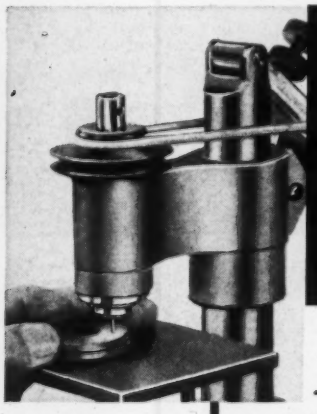
For this literature circle **503** on inquiry card.

Bellows Principles

The Flexon bellows is basically a flexible convoluted tube. Like a diaphragm, it can be made to respond to temperature and pressure changes. Under an axial load it responds like a helical spring. The amount of flexibility depends on the metal used, wall thickness, number of convolutions and other considerations.

In contemplating the use of a bellows, careful consideration must be given to the characteristics of the bellows with respect to the function it is expected to perform. . . . There are two broad groups under which the manufacture of bellows falls. These are bellows and bellows assemblies. Bellows are generally the thin wall corrugated metal elements only, either with or without the integral end, and trimmed with the various types of neck configurations. Bellows assemblies are the basic bellows with attached fittings or built in parts for some specific application, or with some charging fluid or gas sealed into the bellows member.

A bellows is often used as a valve stem seal. . . . A bellows may be used as an effective rotary shaft seal to prevent leakage in a closed system. . . . (they) can compensate for misalignment and bearing play as well as axial



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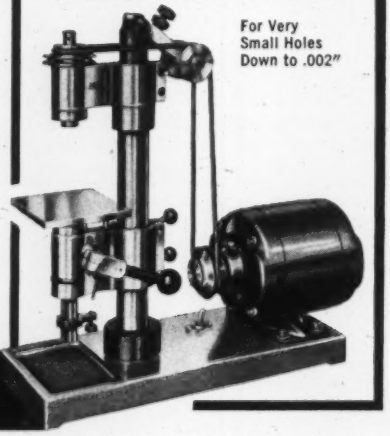

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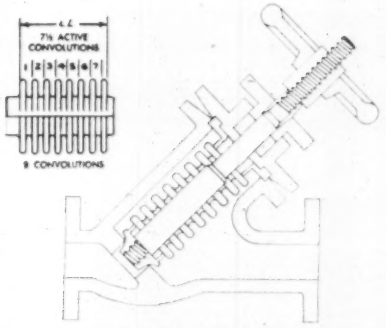

movement. It can be furnished to meet any conditions of temperature, pressure or corrosion, and is available in stainless steel (316, 321, 347), Monel, Inconel, brass and phosphor bronze.

A bellows consists of active convolutions with a neck at each end to which fittings are attached, or by which the bellows can be mounted. Any neck makes part of the last convolution inactive. Only active convolutions are considered in computation. (*From new 16-page Brochure* 145, *Flexonics Corp.*, 1322 *S. 3rd Ave., Maywood, Ill.*)

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Vibrotron

The pressure sensing element of the Vibrotron is basically a fine wire attached to a pressure diaphragm. At its normal tension, this wire vibrates at a natural frequency. As changes in pressure affect the diaphragm, the wire is "tuned" to a higher or lower frequency. This extremely-accurate frequency signal is easily transmitted from point of measurement to any central control point . . . amplified . . . then read directly in pounds per square inch.

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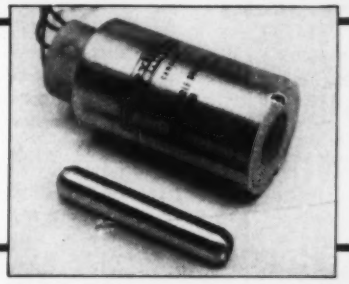

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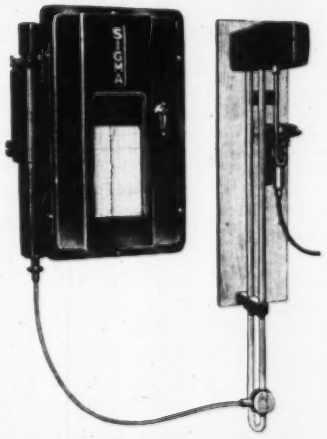

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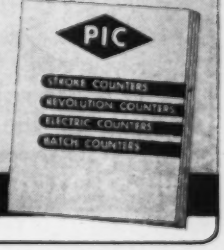

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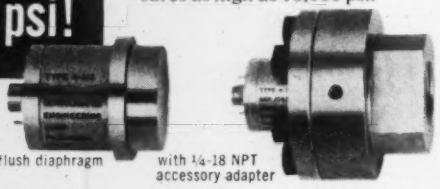

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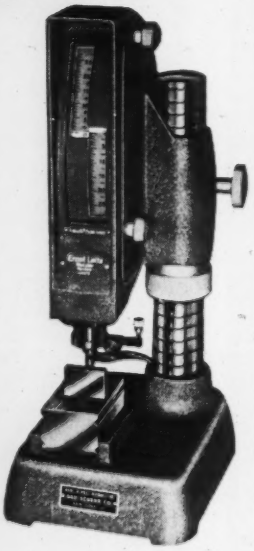

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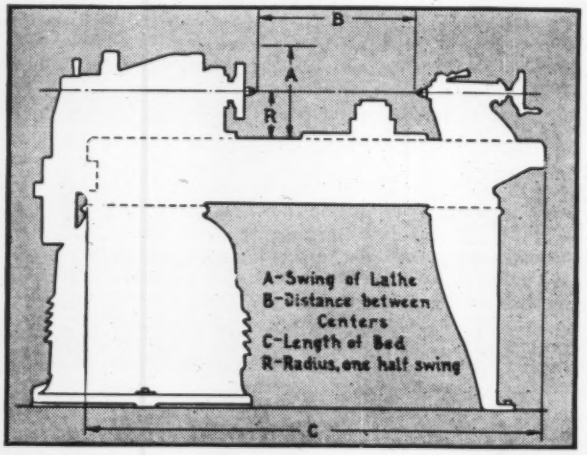
BRIEFS —CONTINUED

placement and acceleration can be measured. In fact, Vibrotron will measure any variable which can cause its diaphragm to change the tension of the highly-sensitive vibrating wire. (*From new 6-page folder, Byron Jackson Co., P. O. Box* 2017, *Terminal Annex, Los Angeles* 45, *Calif.*)

For this literature circle **505** on inquiry card.

How to Run a Lathe

In the United States the size of a Screw Cutting Lathe is designated by the swing over bed and the length of bed, as indicated below. For example, a 16 in. x 8 ft. lathe is one having a swing over the bed "A" sufficient to take work up



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to 16 in. in diameter and having a bed length "C" of eight feet.

European tool manufacturers designate the size of a lathe by its radius "R" or center height. For example, an 8-in. center lathe is a lathe having a radius of eight inches. What the European terms an 8-in. center lathe, the American calls a 16-in. swing lathe.

The swing over the tool rest of the lathe is less than the swing over the bed, and the maximum distance between centers "B" is less than the length of the bed. These figures must be considered carefully as they determine the size of work that can be machined between centers. (*From new 132-page booklet "How to Run a Lathe," South Bend Lathe Works, South Bend 22, Ind.*)

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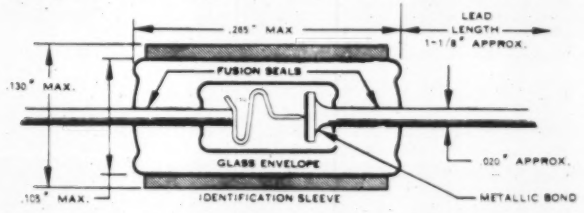
Germanium Diodes

The characteristics of germanium diodes are interrelated in a complex manner. Generally speaking more than one of the characteristics of the diodes depend on each of



the pertinent design variables. Hence, an improvement in one of the design variables by a change in the design in general affects other characteristics and often in a deleterious manner . . . Usually, the low forward conductance diodes have superior high temperature characteristics. Diodes which have forward current minimum ratings up to about 5ma at 1 volt should be chosen when high back

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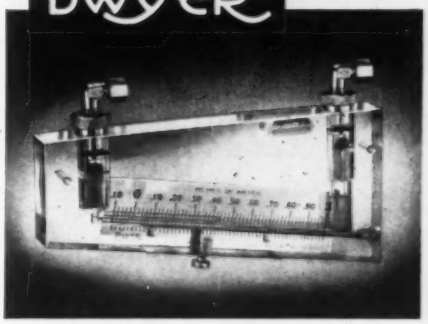

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Write for informative catalog page

DWYER *Specialized* **INSTRUMENTS and GAGES**

F. W. DWYER MFG. CO. • 305 SO. WESTERN AVE. • CHICAGO 12, ILL.

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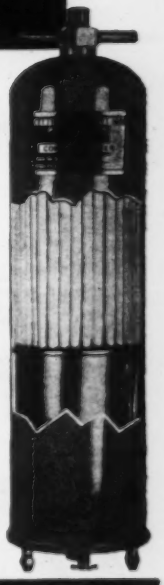
HANKISON PRODUCTS CUT MAINTENANCE COST.

YOU MUST . . . *Condense and filter* . . . if you want "INSTRUMENT-QUALITY" Compressed Air

HANKISON *Condensifilter*



Sets years-ahead filtering standards. When your problem involves Clean, Dry, Air to obtain more efficient, dependable instrument operation, the Hankison Condensifilter offers you a practical low cost solution.

Hankison Condensifilters give greater overall efficiency through these engineering extras -

- Twin Action Principle, that both filters and dehydrates.
- "O" ring seal construction.
- Low maintenance cost.

See why maintenance men are specifying Condensifilters. A qualified engineer is available to consult with you on all compressed air problems.

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BOOST 100 PSI AIR PRESSURE TO 30,000 PSI FLUID PRESSURE

for...

$289.50

(F.O.B. Gardena, Calif.)

Continuous-acting, air-driven. Various ratios give maximum fluid pressures of 100 to 50,000 psi. Size: 8¼" wide x 9⅝" deep.

Eight standard models. Special models for lower or higher pressures. Applicable wherever low-volume output at high pressures is the requirement, such as static testing, powering presses for forming, shearing, clamping, etc. Thousands in use. Complete power packages also available. Send for Bulletins.

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Engineering Corporation

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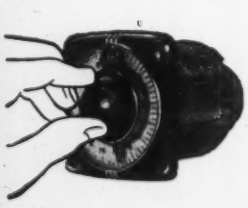
For more information circle **121** on inquiry card.

low cost
... inventory
... installation
... maintenance

miniature
... for space economy



maximum circuit flexibility
... more than 145 electrical arrangements

An entirely new concept in automatic time interval control, Atcotrol is designed to be the standard in its field.

Requires but one clearance hole for mounting. Atcotrol timer can be demounted from panel in 2 seconds without tools. Completely serviced with a screwdriver. Either reset or stop on power failure. Motor, clutch and reset operation visible from front. Instantaneous reset. No pointer rebound. Built to NEMA standards. Conservatively rated at 10 amps. *Repeat accuracy within .1 of 1%.* Many other new and exclusive features.

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ATCOTROL
RESET TIMERS

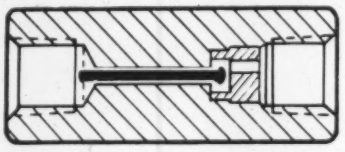
For more information circle **122** on inquiry card.

resistance at high temperatures is required. These diodes have high initial back resistance and they lose this resistance less rapidly than the higher conductance units as the temperature is increased . . . The shape of the back current curves, particularly in the low voltage region, is another difference between high and low forward conductance units.

Temperature exerts a very pronounced effect on the characteristics of all semiconductors, including germanium. (*From new 8-page Brochure SP2A, Semiconductor Div., Hughes Aircraft Co., Culver City, Calif.*)

For this literature circle **507** on inquiry card.

Pressure Gage Snubbers



Pressure fluctuations in fluid circuits are often very severe, and consequently ruinous to pressure gages. Fluid hammer, relief valves, chattering check valves, and pump pulsations can cause extreme shock which may damage the gage. The Republic Pressure Gage Snubber absorbs the shock, and permanently protects the gage against damage from wild fluctuations, without affecting its accuracy. (*From new 68-page Catalog 654, "Republic Valves," Republic Mfg. Co., Cleveland 11, Ohio.*)

For this literature circle **508** on inquiry card.

Light-Scattering Photometer

The new Brice-Phoenix Universal Light-Scattering Photometer 1000 Series is designed for measurement of micro-scattering, micro-fluorescence, micro-luminescence, and low

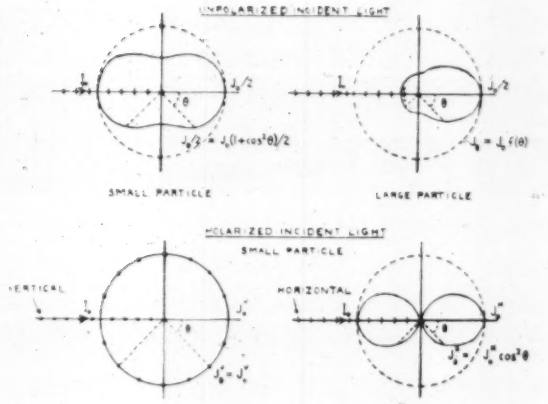
NEW TRANSFORMER CORE!

Valparaiso, Indiana, April, 1955 —The Indiana Steel Products Company has developed a new product...a wound core, consisting of just ONE PIECE, not two pieces as in conventional C-type cores.

ADVANTAGES: One air gap, instead of two gives better performance ...exciting current normally lower, often by significant amount. Vacuum impregnating unnecessary...resulting electrical losses eliminated. No "halves" to mix up. Slight "tilt," sometimes present on ground pole faces of C-cores, completely eliminated.

Manufacturing economies reflected in low price. For descriptive literature, write Indiana Steel Products Co., Dept. D-5 Valparaiso, Indiana.

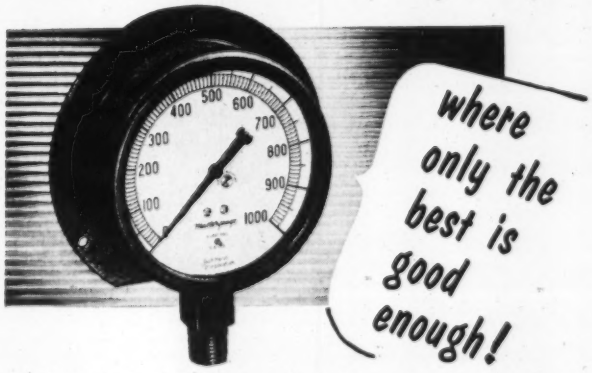
For more information circle **123** on inquiry card.



transmittance and reflectance of dark materials. . . . It is the latest improved form of the apparatus described by B. A. Brice, M. Halwer, and R. Speiser, J. Opt. Soc. Am. 40, 768 (1950) for the determination of molecular weights. This photometer is a complete self-contained instrument for measuring the absolute TURBIDITY, DISSYMMETRY, and DEPOLARIZATION of dilute solutions of high molecular weight compounds. Weight-average molecular weights can be determined from these data and from refractive index measurements by use of the theory developed by Debye and others. In addition, the maximum dimension of the molecule can be estimated from the dissymmetry measurement provided the molecule is sufficiently large; and the solute molecule can be classified as to size and anisotropy from the depolarization measurements. Changes in molecular weight, particle size, and anisotropy can be rapidly followed. (*From new 20-page Bulletin B-P* 1000, *Phoenix Precision Instrument Co.*, 3803 *N. 5 St., Phila.* 40, *Pa.*)

For this literature circle **509** on inquiry card.

MARSH *Mastergauge*



Always the best of the better gauges, Mastergauge has been given *plus* features that further lengthen its lead.

A still better tube construction: Socket, tube and end piece are now all fused into *one* leak-tight unit by the new Marsh "Conoweld" process.

A still better case: New copper clad wrought steel "Marshalloy" case has the corrosion resistance of pure copper; weighs one third as much as cast iron, and is *four times* as strong.

An even finer movement: Further refinements are added to the rugged, corrosion resistant, virtually frictionless stainless steel and monel Mastergauge movement. A typical refinement is the "coined" (extruded) sector gear which contributes extra strength and precision.

Where only the best is good enough—in the most critical industrial refinery and oil country services—"Mastergauge" is your instrument.

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Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alta.

For more information circle **124** on inquiry card.

Quality SMALL TUBING
in COPPER and COPPER BASE ALLOYS

★ THIN WALL Tubing
★ BRAIDED Tubing
★ CAPILLARY Tubing
★ BOURDON Tubing
★ SHAPE Tubing

For *better* measurement and control in Industrial Instruments

Since 1909 we have specialized in the manufacture of seamless bourdon and capillary gauge tubing for instruments, gauges, pressure control and recording equipment, and for applications requiring tubing of accurate gauge and fine finish.

Years of manufacturing experience, plus modern mill equipment, rigid production and laboratory control assure both excellence and uniformity in every foot of tubing for maximum production and efficiency.

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Write for Catalog MW-A

THE MACKENZIE WALTON CO.
PAWTUCKET • RHODE ISLAND
Sales Representatives: COREY STEEL COMPANY
2800 South 61st Court Chicago, Illinois

For more information circle **125** on inquiry card.

For after shutdown protection...

AGASTAT®

TIME DELAY RELAY

Allows operation of auxiliary protective devices* after operating cycle is stopped. Easily installed in any electrical line.

The AGASTAT is—

- light, versatile, dependable.
- instantaneous recycling.
- unaffected by voltage variations.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in models that offer delays on energizing and de-energizing, two step delays, manually-actuated time delay switch, remote push button control.

***WRITE** for new 4-page application folder describing how one large company solved its after-operating problem. Address Dept. A21-59*

AGA DIVISION
Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

For more information circle 126 on inquiry card.

New Literature...

INSTRUMENTS and AUTOMATION

For literature use the postage-free order card on page 845.

AUTOMATION

Industrial Instrumentation. New 24-page Catalog 5002 presents maker's large and complete line of industrial instruments—pyrometers, potentiometers, thermometers, pressure gages, flow and level meters, transmitters, data loggers, combustion safeguards, control valves, etc.—Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.

Circle **510** on inquiry card.

Process Controller. New 12-page Bulletin 5A-13 describes maker's "Model 41A" pneumatic indicating controller for controlling process variables.—Foxboro Co., Foxboro, Mass.

Circle **511** on inquiry card.

Reactor Controls. New 8-page Brochure ND46-70-700 (1) presents design, instrumentation, and fabrication of maker's complete "package" control systems for operation of any type of research or power reactor.—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Circle **512** on inquiry card.

"Inductronic" Control System. New 12-page Catalog B-36-A describes maker's "Inductronic System" for measurement and control, featuring moving-coil movement, inductive pick-up of 200-kc signal, electronic amplification and rectification, and feedback to input for potentiometric balance. Includes application for d-c amplifiers, integrating fluxmeters, limit and knife-edge control units, and product resolvers.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Circle **513** on inquiry card.

Control Panel Colors. New Specification Sheet G71-2 presents full-color illustrations of standard colors for "Types KM & WM" panels and recorders.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **514** on inquiry card.

Light Control. New 12-page Booklet L155P describes maker's packaged light control equipment for dimming, brightening and blending of light.—Superior Electric Co., Bristol, Conn.

Circle **515** on inquiry card.

Automatic Control. New 12-page Bulletin G-7 pictures and describes maker's "Slim-Ply-Trol and Versatrol" automatic controls for heat, speed, radiation, voltage, current, pH, etc.—Assembly Products, Inc., Chesterland, Ohio.

Circle **516** on inquiry card.

Blast-furnace Automation. New 4-page Bulletin RH5 describes maker's automatic program-control equipment for charging blast furnaces.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago, Ill.

Circle **517** on inquiry card.

Kiln Control. New 4-page issue of "Wheelco Comments" (No. 1, Vol. 15) discusses control of a continuous tunnel kiln used for firing of special refractories.—Barber-Colman Co., Rockford, Ill.

Circle **518** on inquiry card.

Furnace, Oven Control. New 48-page Bulletin P 1260 presents maker's large line of control instruments for furnaces, ovens, dryers, and kilns.—Bristol Co., Waterbury 20, Conn.

Circle **519** on inquiry card.

Servo Amplifiers. New 4-page leaflet pictures and describes maker's "Model B-1" magnetic servo amplifiers used in synchro transmission systems.—Feedback Controls, Inc., 1332 N. Henry St., Alexandria, Va.

Circle **520** on inquiry card.

Machine Control. New 2-page supplement "Relay Highlights No. 4" describes new uses for telephone-type relays in precision control of machine processes.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle **521** on inquiry card.

"Proximotrol" Control. New 4-page bulletin describes new "Proximitrol" electronically-operated sensing and triggering device for pickup of basic intelligence used in control of industrial or process operations.—Paul Morrow Co., Inc., P. O. Box 1701, Wilmington, Del.

Circle **522** on inquiry card.

"Capacitrol." New 16-page Bulletin 9 describes maker's "Capacitrol" controller featuring millivoltmeter, "electronic link," and various types of output devices. Also application to various control installations.—Barber-Colman Co., Rockford, Ill.

Circle **523** on inquiry card.

Load Indicator. New Bulletin MLI-1.1 describes and illustrates maker's "MEK-2127" motor load indicator for preventing damaging overloads, tool breakage, etc.—Machinery Electrification, Inc., Northboro, Mass.

Circle **524** on inquiry card.

Smoke Controller. New 2-page Bulletin 553 illustrates maker's "Model AC-1" smoke control alarm for split second detection of smoke by "electric eye" monitoring of gases.—Ess Instrument Co., 96 S. Washington Ave., Bergenfield, N. J.

Circle **525** on inquiry card.

Pump Control. New 4-page Bulletin L-119 pictures and describes maker's "Series 92" pump control for pressures up to 250 lbs.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

Circle **526** on inquiry card.

Defense Materials Control. New 46-page booklet "The Defense Materials System in Our American Industry" presents new rules now in effect which stress need for a functioning material control system permitting rapid industrial mobilization in case of war. Price $.25.—Dept. of Commerce, Business and Defense Services Administration, Washington 25, D. C. Please write direct.

Load Control. New set of 2-page bulletins describe maker's "MEK-2128" load control for protecting tapering rolling mills, punch presses, milling machines, etc. from damaging overloads.—Machinery Electrification, Inc., Northboro, Mass.

Circle **527** on inquiry card.

Speed Drives. New set of 2-page bulletins describe and illustrate maker's "MEK-2158" fractional-hp adjustable-speed drives for holding speed through load variations from no load to full load.—Machinery Electrification, Inc., Northboro, Mass.

Circle **528** on inquiry card.

Machine-tool Automation. New 2-page bulletin describes maker's "magnetic programming" process for magnetic-recording drive control of machine tools.—Automation Corp. of America, Div. Magnasync Mfg. Co., Ltd., 5523 Satsuma Ave., N. Hollywood, Calif.

Circle **529** on inquiry card.

Automated Lubrication Systems. New 4-page Bulletin 806 describes maker's "Model 82570" automatic air-operated lubrication system and "Model 82571" automatic air-operated spring return system.—Lincoln Engineering Co., 5701 Natural Bridge Blvd., St. Louis 20, Mo.

Circle **530** on inquiry card.

Pneumatic Relays. New Bulletin 359 describes maker's pneumatic relays and pilot valves, pressure-electric switches and electric pneumatic valves.—Powers Regulator Co., Skokie, Ill.

Circle **531** on inquiry card.

Automated Furnaces. New 4-page Bulletin SC-169 pictures and describes maker's mechanized standard rated furnaces and built-in conveyors.—Surface Combustion Corp., Toledo 1, Ohio.

Circle **532** on inquiry card.

Control Boards. New 6-page leaflet describes maker's custom control panels for boilers, turbo-generators, special assemblies, etc.—Clement Electric Co., Grand Rapids, Mich.

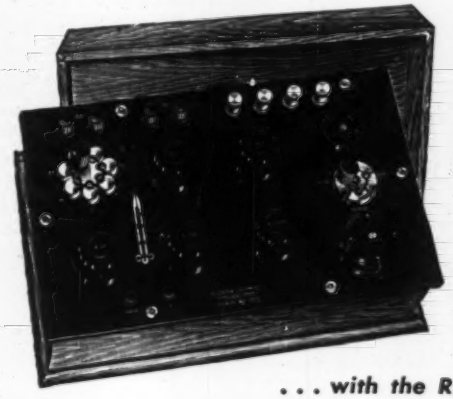
Circle **533** on inquiry card.

Water Control. New 4-page issue of "Autocon Rambler" (Vol. 7, No. 1) discusses use of "Autocon" bubbler control to eliminate probe maintenance and assure system control.—Automatic Control Co., 1005 University Ave., Saint Paul 4, Minn.

Circle **534** on inquiry card.

Precise

TEMPERATURE MEASUREMENTS

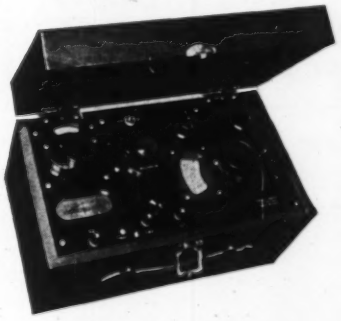


. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge-zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



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PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

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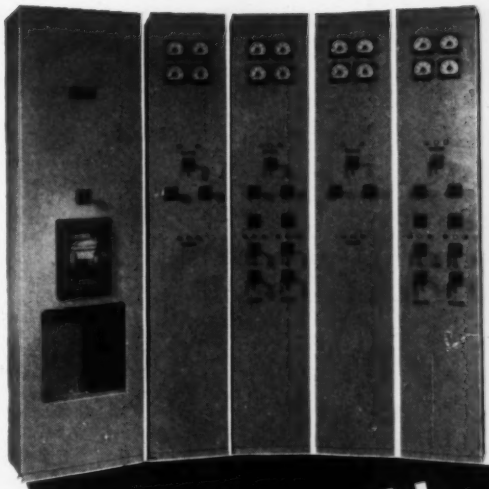
Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **127** on inquiry card.



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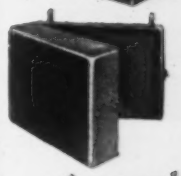
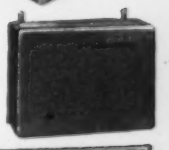
Custom-Built by KIRK & BLUM

ONE or one thousand, from a small timer case to a huge control panel, Kirk and Blum produces all kinds of metal enclosures, quickly and economically.

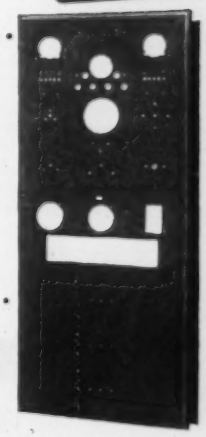
Complete facilities for fabrication of sheet steel, plate, light structurals, stainless, aluminum, monel, and other alloys.

Send your prints to Kirk and Blum for prompt quotation. More detailed information is available in new literature describing fabrication facilities and experience. Write to: The Kirk and Blum Mfg. Co., 3111 Forrer Street, Cincinnati 9, Ohio.





CONTRACT MANUFACTURING FACILITIES for: Control Desks • Boiler, Turbine and Generator Control Panels • Power Distribution and Control Panels • Switch Gear Housings • Cubicles • Instrument Panels • Machine Bases • Electrical Enclosures • Breechings • Transformer Enclosures • Air Ducts • Stacks • Weatherproof Housings • Hoppers



KIRK & BLUM METAL FABRICATION

For more information circle **128** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Sorting Machine. New 8-page issue "Hirschmann Highlights" (Jan. 1955) describes and illustrates maker's "Censor" automatic parts-sorting machine.—Carl Hirschmann Co., Inc., 30 Park Ave., Manhasset, N. Y.

Circle **535** on inquiry card.

Engine Control. New 4-page Bulletin FP presents description of maker's automatic control for engines, engine-driven fire pumps, etc.—King-Knight Co., 360 Jefferson St., San Francisco 11, Calif.

Circle **536** on inquiry card.

MOTORS

Motor Control. New 68-page Catalog GEC-1260A presents large line of motor starters, contactors, relays, solenoids, switches, push buttons, and pilot devices.—General Electric Co., Schenectady 5, N. Y.

Circle **537** on inquiry card.

Motors. New 28-page Catalog GEC 1026 presents information on maker's standard a-c fractional and integral horsepower and fhp gear motors.—General Electric, Schenectady 5, N. Y.

Circle **538** on inquiry card.

Synchronous Motors. New 6-page illustrates Folder EI-5A describes maker's self-synchronous motors for remote indication, computation, and process control.—Electric Indicator Co., Inc., Camp Ave., Springdale, Conn.

Circle **539** on inquiry card.

Servomechanism Components. New 4-page bulletin lists characteristics and specifications of over 130 synchros, servo motors, resolvers and amplifiers. 4-page bulletin describes company's products facilities and special services.—Norden-Ketay Corp., 99 Park Ave., New York 16, N. Y.

Circle **540** on inquiry card.

Synchronous Motors. New 4-page illustrated Catalog 403-2 presents specifications on maker's hysteresis synchronous motors for high-fidelity recording and reproducing equipment.—Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.

Circle **541** on inquiry card.

Synchros, Motors. New technical data sheet presents technical data and illustrations on maker's line of synchros, servo torque units, a-c drive motors, d-c motors, a-c servo motors, tachometer generators, actuators and motor-driven blowers and fan assemblies.—John Oster Mfg. Co., 1 Main St., Racine, Wis.

Circle **542** on inquiry card.

Servomotor. New March 1955 Bulletin 2464-1 describes maker's miniature a-c servomotors with tachometer generators. Form 2395-6 describes miniature servomotors "Size 15".—G-M Laboratories, Inc., 4300 N. Knox Ave., Chicago 41, Ill.

Circle **543** on inquiry card.

Synchronous Motor. New 4-page issue of "Bodine Motorgram" (Vol. 35, No. 2) discusses characteristics and application of synchronous motors.—Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

Circle **544** on inquiry card.

VALVES

Control Valves. New 4-page Bulletin 100 pictures and describes maker's "Flo-Tested microflo" control angle valve with spline plug for process control.—Hammel-Dahl Co., 175 Post Rd., (Warwick), Providence 5, R. I.

Circle **545** on inquiry card.

Valves. New 66-page catalog describes and illustrates maker's line of 2-way, 3-way and 4-way air control valves for diesel starting, fuel safety-relief, grease-lubrication control, and process systems.—Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.

Circle **546** on inquiry card.

Diaphragm Seals. New Bulletin 201 presents diagrams on typical installations and table of standard specifications of maker's Bellofram diaphragm seals for cylinder operators.—Bellofram Corp., 144 Moody St., Waltham, Mass.

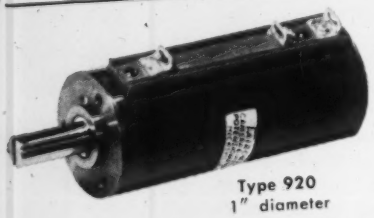
Circle **547** on inquiry card.

Solenoid Valves. New 2-page Bulletin F-1 presents specifications on maker's "Types F & G" solenoid valves hermetically sealed in thermoplastic casing.—J. D. Gould Co., 730 E. Washington St., Indianapolis, Ind.

Circle **548** on inquiry card.

DATA SHEET

FAIRCHILD PRECISION POTENTIOMETERS



Type 920
1" diameter

Ten-turn Potentiometer (24½" coil length)

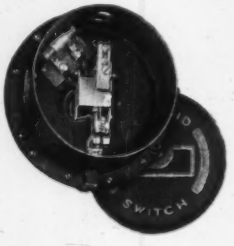
This unit has only one-half the diameter and one-third the weight of usual standards. Its all-metal case construction results in greater rigidity and strength, and sustained higher electrical and mechanical accuracy throughout the life of the unit. The Type 920 offers superior resistance to severe environmental conditions. Available with servo, threaded bushing or pilot 3-hole mounting — and ball bearings. 200,000 ohms max. resistance; standard linearity, ± 0.25% (±0.1% special). Low starting torque of 1 oz. in.

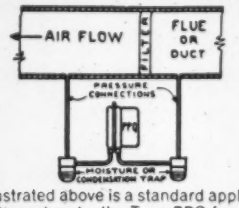
SAMPLES AVAILABLE ON ORDER

Fairchild's more complete line can help solve all your precision potentiometer problems. For more information write Fairchild Camera and Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., Dept. 140-63B.

For more information circle **129** on inquiry card.

CONTROL FROM MINUTE CHANGES IN THE RELATIONSHIP OF TWO PRESSURES





Illustrated above is a standard application whereby the Type PPQ functions to open (or close) an electrical circuit from a variation in pressure differential due to a clogging filter.

Mercoid Type PPQ Diaphragm Differential Pressure Controls operate from minute changes (.03" water) in the difference between two pressures.

Ranges to cover most applications (inches of water) 6" vacuum to 6" pressure, and 30" vacuum to 30" pressure. Available for various circuit arrangements.

Electrical Capacity—0.3Amp. at 115V., A.C. or 0.15 Amp., at 230V., D.C. Can be furnished in explosion-proof or weather-proof cases.

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New York: 205 East 42nd St. Philadelphia: 3137 N. Broad St.

For more information circle **130** on inquiry card.

Regulating Valves. Two new 2-page bulletins describe maker's "Type HT" temperature-actuated regulating valve for controlling hot water or steam; and "Type WT" for water, brine, oil, gas, or industrial processes.—Electrimatic Co., Skokie, Ill.

Circle **549** on inquiry card.

Solenoid Valves. New 12-page Booklet 215 describes maker's "Electro-Mite" solenoid valve for small flow-rate applications of 2/10 to 6/10 gpm water.—Hays Mfg. Co., Erie, Pa.

Circle **550** on inquiry card.

Valves. New 12-page Brochure 231 describes maker's "Electro-Mesurflo" electrically-operated valve for medium-flow-volume applications, and featuring new "Mesurflo" principle using rubber diaphragm and machined grooves and hole of brass orifice plate.—Hays Mfg. Co., W. 12th St., Erie, Pa.

Circle **551** on inquiry card.

Control Valves. New 12-page Bulletin No. 3037 describes and illustrates maker's fluid-control valves, including needle, toggle, midget diaphragm, imperial diaphragm blow-down, test, "Kwik" disconnect etc.—Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

Circle **552** on inquiry card.

TEMPERATURE

Thermocouples. New 56-page Bulletin P 1238 describes and illustrates maker's thermocouples, protecting tubes, connection heads, thermocouple extension wire, and pyrometer accessories.—Bristol Co., Waterbury 20, Conn.

Circle **553** on inquiry card.

Temperature Control. New 4-page Bulletin G-8 describes maker's automatic temperature control and limit control for safety shut-off or warning. Bulletin 108 presents specifications on relays and plug-in components.—Assembly Products, Inc., Chesterland, Ohio.

Circle **554** on inquiry card.

Thermocouples, Glands. New Bulletin 54-AA describes and illustrates maker's adjustable pipe-clamp thermocouples for reading outside pipe temperatures; 2-page Bulletin 54TT presents thermocouple glands for pressures to 5000 psi; 2-page Bulletin 55-B presents new compact thermocouple head.—Conax Corp., 4515 Main St., Buffalo 21, N. Y.

Circle **555** on inquiry card.

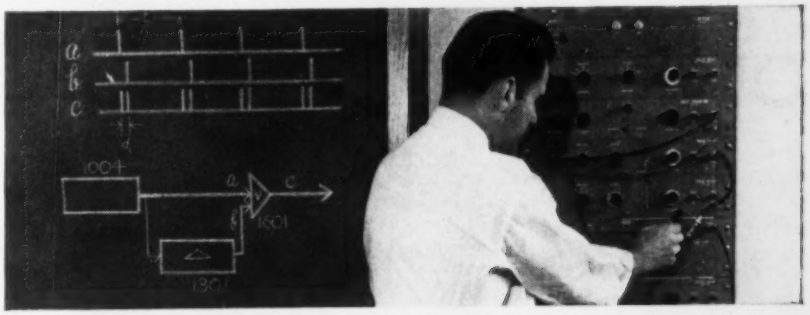
Temperature Controller. New Bulletin MC-121 presents application ideas and performance specifications on maker's adjustable remote-bulb temperature controller for handling large electrical loads up to 35 amps at 120 volts a-c.—Fenwal, Inc., Ashland, Mass.

Circle **556** on inquiry card.

Cooling Devices. New 8-page bulletin presents applications and illustrations of maker's fans and blowers for electronics industry.—Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.

Circle **557** on inquiry card.

Engineer using BURROUGHS PULSE UNITS loses no time designing test equipment



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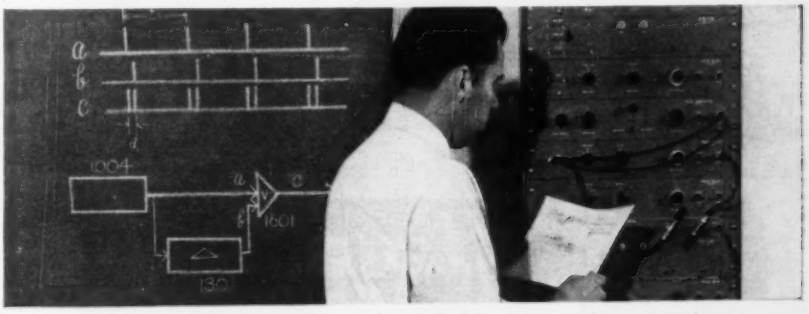
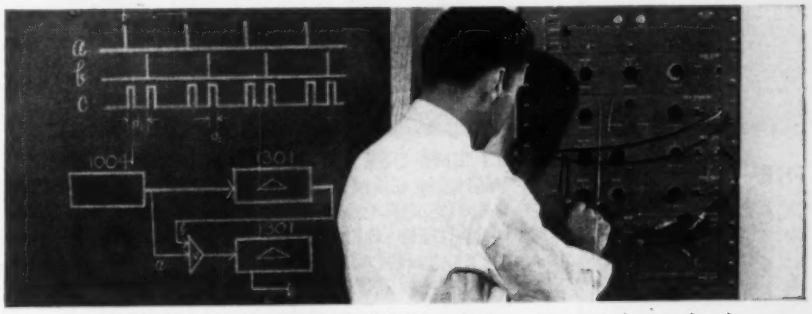


2. **JOB COMPLETED.** No time lost. Because engineer spends no time designing test equipment, he can spend his full time on the real problem. This means he can do more, accomplish more.



3. **NEXT ASSIGNMENT.** Without losing time, engineer simply determines the block diagram needed to produce the next pulse sequence and sets up his Burroughs Pulse Units. He shifts quickly from one assignment to the next—saving considerable time otherwise needed to design and build special test equipment.

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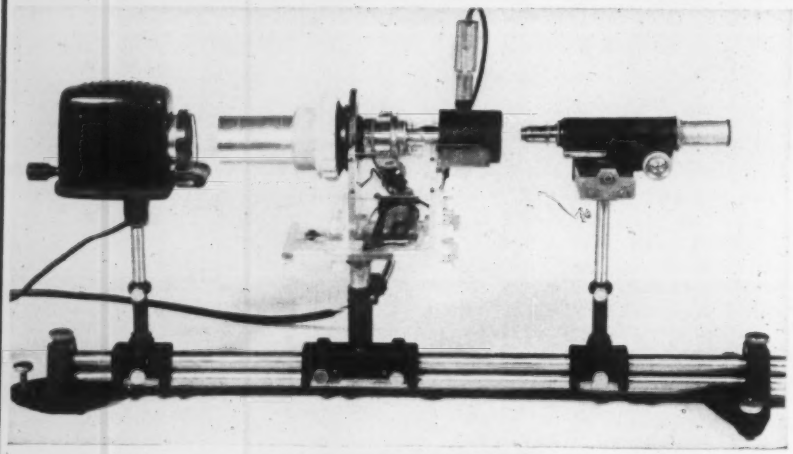

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NEW LITERATURE

Lab Ovens. New 4-page Bulletin 5510 illustrates maker's "Power-O-Matic" industrial batch ovens, air-draw furnaces, box-type muffle furnaces, etc.—Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

Circle **558** on inquiry card.

WEIGHT, PRESSURE

Strain Gages. New 16-page issue of "CEC Recordings" (Vol. 9, No. 2) features article on strain-gage theory. Other articles are on data reduction and mass spectrometry.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **559** on inquiry card.

Load Cells. New 20-page Bulletin 4301 describes and illustrates maker's "SR-4" load cells and load beams for electrical measurement of weight and force.—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

Circle **560** on inquiry card.

Load Calibration. New 4-page Bulletin 115 describes maker's universal calibrating machine for calibration of static load-sensing elements.—Morehouse Machine Co., York, Pa.

Circle **561** on inquiry card.

Weighing System. New 2-page technical reference describes and illustrates maker's automatic weighing and bulk handling systems. Outlines complete sequence of operation for weighing, indicating and delivery cycles.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **562** on inquiry card.

Pressure-controlled Oscillator. New 2-page bulletin pictures maker's "Series 0200" inductance-controlled telemetering oscillator for measurement and control of tank liquid level, pressure, etc.—Datran Engineering Corp., 6312 W. 92 St., Los Angeles 45, Calif.

Circle **563** on inquiry card.

Leak Detector. New 2-page bulletin describes and illustrates maker's "Leak-Tec" for detecting leaks in gas lines, industrial equipment, transformers, tanks, air brakes, electronic equipment, etc.—American Gas & Chemicals, Inc., 45 Rockefeller Plaza, New York 20, N. Y.

Circle **564** on inquiry card.

FLOW, PUMPS

Flowmeter. New 4-page Specification Sheet AF-1 describes maker's airborne flowmeter, flow rate and total flow indicator, and frequency converter for recording flow data during flight testing.—Potter Aeronautical Co., U. S. Route 22, Union, N. J.

Circle **565** on inquiry card.

Rotameter Kits. New 8-page Bulletin 140 presents design and construction details on maker's rotameter kits for research laboratory, pilot plant and field testing.—Brooks Rotameter Co., Lansdale, Pa.

Circle **566** on inquiry card.

Gasoline Blender. New 8-page Bulletin 725 describes maker's precision "Automatic Reid" for blending A.S.-T.M. gasoline.—Precision Scientific

Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **567** on inquiry card.

Chemical Pumps. New 4-page Bulletin describes maker's line of small, rotary, displacement and centrifugal pumps for chemical service.—Eco Engineering Co., 12 New York Ave., Newark, N. J.

Circle **568** on inquiry card.

Displacement Pump. New Bulletin 1100-M1 describes and illustrates maker's "Model 1105 Adjust-O-Feeder" displacement pump for proportioning solutions or chemicals.—Proportioneers, Inc., 345 Harris Ave., Providence 1, R. I.

Circle **569** on inquiry card.

Feeder Control. New Application Memo B-I-F K24 describes function of maker's venturi meter and "rotodip" liquid feeder for continuous metering and treating of paper-mill water supplies with liquid alum.—Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle **570** on inquiry card.

Chemical Feeders. New Bulletin 19-10-3 describes maker's "Chlor-O-Mite" (Models E and H) low-capacity chemical feeders for controlled feeding of hypochlorite into small water systems.—Proportioneers, Inc., Div. B-I-F Industries, Providence 1, R. I.

Circle **571** on inquiry card.

Pumps. New 2-page leaflet presents information on maker's "Vanton X-B" pump for handling severe corrosive chemicals and abrasive slurries.—Vanton Pump & Equipment Corp., 201 Sweetland Ave., Hillside, N. J.

Circle **572** on inquiry card.

RECORDING

36-Channel Oscillograph. New 4-page brochure describes maker's "Model 544" oscillograph which records up to 36 separate channels of data.—Midwestern Instruments, P. O. Box 7186, Tulsa, Okla.

Circle **573** on inquiry card.

Bridge Balance Unit. New 4-page Bulletin MI-2 describes and illustrates maker's "Model 430" bridge balance unit for lab or flight test work.—Midwestern Instruments, P. O. Box 7186, Tulsa, Okla.

Circle **574** on inquiry card.

Oscillography. New 8-page issue of "Right Angle" (Vol. 2, No. 3) features articles on applications of direct-writing oscillographs in field operations.—Industrial Div., Sanborn Co., Cambridge 39, Mass.

Circle **575** on inquiry card.

Oscillographic Recorder. New 4-page descriptive booklet illustrates maker's "Type 550-A" direct-writing oscillographic recorder with response to 900 cycles.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **576** on inquiry card.

Multipoint Measuring System. New 2-page Technical Bulletin (March, 19-55) describes maker's new multipoint measuring system for physical quantities.—Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.

Circle **577** on inquiry card.

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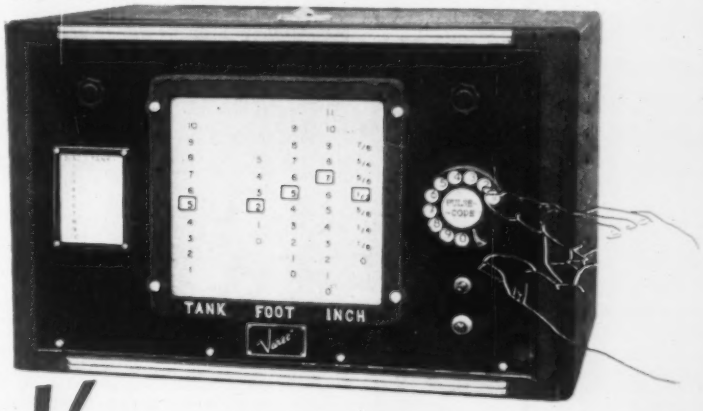

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- Read-Out—Cycles per second: Five digits

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- Stability—1 part in 100,000 (1 part in 1,000,000 with crystal oven)
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NEW LITERATURE

RADIOACTIVITY

Radiography. New 12-page booklet presents information required for setting up or operating gamma-radiography installation; selecting proper radioisotope for handling equipment and principle of radiation safety.—Technical Operations, Inc., 6 Schouler Court, Arlington, Mass.

Circle **578** on inquiry card.

Geiger Counter. New 2-page bulletin describes maker's "Micro Model B" transistor geiger counter that requires only a single 1.5-volt mercury cell and operates 100 hrs. on single battery.—Transi-Mite Laboratory, Radiation Counter Div., Manteo, N. C.

Circle **579** on inquiry card.

Geiger Counters. New 4-page booklet presents maker's geiger and scintillation counters, URA finder, radiation survey meter with scale-change meter, well logger probe, military-type geiger counter and "Eldorado" portable geiger counter.—El-Tronics, Inc., Fifth and Noble Sts., Philadelphia 23, Pa.

Circle **580** on inquiry card.

Radiation Monitor. New 2-page bulletin describes and illustrates maker's "Dosifilm" monitoring badge for dosage accumulated by wearer.—R-C Scientific Instrument Co., Inc., 307 Culver Blvd., Playa Del Rey, Calif.

Circle **581** on inquiry card.

Scintillation Counter. New 2-page bulletin describes and illustrates maker's "Airsco" airborne scintillation counter for continuous plotted readings of radiation level.—Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif.

Circle **582** on inquiry card.

MOTION, VIBRATION

Impact Recording. New 4-page leaflet describes and illustrates maker's "Impact-O-Graph" for recording magnitude and direction of impact in all directions.—Impact-O-Graph Corp., 1900 Euclid Ave., Cleveland 15, Ohio.

Circle **583** on inquiry card.

Accelerometers. New Bulletin AA2 presents specifications and diagrams of maker's angular accelerometers for studying rotary motion of a test body.—Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle **584** on inquiry card.

Rotor Balancer. New 4-page bulletin describes and illustrates maker's rotor balancer for detecting components of rotor vibrations arising from static and dynamic unbalance.—M. Ten Bosch, Inc., Pleasantville, N. Y.

Circle **585** on inquiry card.

LABORATORY

3-D Microscopes. New 38-page Catalog D-15 describes 3-D microscopes for industrial assembly lines and research labs.—Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.

Circle **586** on inquiry card.

Lab Glassware. New 4-page bulletin features details on maker's "Diamond D Blue Line" of lab glassware which has had double-test for accuracy, electrically-controlled annealing for removing internal strain, fusing of blue pigment in graduations, etc.—Doerr Glass Co., Boulevard and Peach Sts., Vineland, N. J.

Circle **587** on inquiry card.

Micropipettes. New 4-page Bulletin 155 pictures maker's line of micropipettes used in electrophoresis, chromatography, blood analysis, etc.—Research Specialties Co., 1148 Walnut St., Berkeley 7, Calif.

Circle **588** on inquiry card.

Anhydrous Ether. New 4-page Booklet 5872 presents description of maker's anhydrous ether requiring no preliminary drying.—Mallinckrodt Chemical Works, Second and Mallinckrodt Sts., St. Louis 7, Mo.

Circle **589** on inquiry card.

ANALYTICAL

Infrared Analyzer. New 4-page Folder DWO 1542 presents the "Phillips 66" infrared analyzer for continuous analysis of production streams.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **590** on inquiry card.

Diffractometer. New 12-page Catalog CH 322/3 illustrates and describes maker's X-ray diffractometer for investigation of solid crystals by direct measurement of diffracted intensity using a high-speed ratio pen recorder.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Circle **591** on inquiry card.

Gas Analyzers. New 8-page issue of "L-B Analyzer" (Vol. 1, No. 1) features article on "Gas Analyzers in Pilot Plant operation."—Liston-Becker Instrument Co., Inc., Springdale, Conn.

Circle **592** on inquiry card.

Spectrophotometers. New 16-page Booklet SB1-104 describes and illustrates "Cary" recording "Models 11 and 14" spectrophotometers for recording of spectra. Includes information on infrared and ultraviolet analyzer, electrometers and Raman spectrograph—Applied Physics Corp., Pasadena, Calif.

Circle **593** on inquiry card.

Viscometers. New 12-page booklet describes maker's viscometers based on the Drage rheometer—a freely-suspended motor driving measuring bob in substance to be measured.—Drage Products, 406-32nd St., Union City, N. J.

Circle **594** on inquiry card.

Refractometer. New 2-page New Product Bulletin (No. 16) pictures and describes maker's pocket refractometer for determining solids content or refractive index of liquids or semi-liquid products.—National Instrument Co., 5005 Queensberry Ave., Baltimore 15, Md.

Circle **595** on inquiry card.

pH Electrodes. New 4-page reference table lists sixty most widely used Beckman pH electrodes. Presents descriptions, temperature and pH

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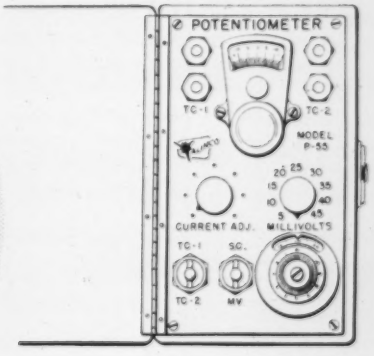

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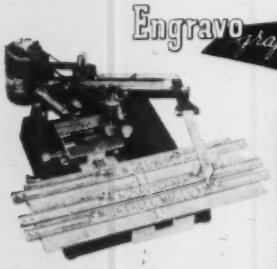

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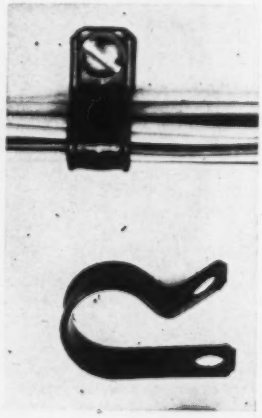

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For more information circle **139** on inquiry card.

NEW LITERATURE

ranges, body and lead lengths, catalog numbers and prices.—Will Corp., Rochester 3, N. Y.

Circle **596** on inquiry card.

Analytical Instrument. New 6-page bulletin describes and illustrates maker's "Quantograph" which can be used as a spectrograph, quantometer, or monochromator.—Applied Research Labs., 3717 Park Place, Glendale 8, Calif.

Circle **597** on inquiry card.

Spectrometer. New 4-page bulletin describes maker's x-ray scanning spectrometer for analyzing liquids, powders, solids, etc.—Applied Research Labs., 3717 Park Place, Glendale 8, Calif.

Circle **598** on inquiry card.

Control Analysis. New 4-page Bulletin 42 describes maker's "Spectromet" direct-reading spectrometer for producing data directly on dial indicators in form of element concentrations.—Baird Associates, Inc., 33 University Rd., Cambridge, Mass.

Circle **599** on inquiry card.

Flame Photometer. New 8-page issue of "Beckman Bulletin" (No. 16) features article on "New Flame Photometer Speeds, Simplifies Na, K Analyses."—Beckman Instruments, Inc., Fullerton, Calif.

Circle **600** on inquiry card.

Spectrograph. New 8-page Folder D-272 presents specifications on maker's dual-grating spectrograph.—Bausch & Lomb Optical Co., Rochester 2, N. Y.

Circle **601** on inquiry card.

Spectrometer Attachments. New 4-page bulletin describes maker's line of spectrometer attachments for qualitative and quantitative analysis and molecular structure investigations of natural and synthetic fibers, single crystals, biological tissue sections, etc.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **602** on inquiry card.

GAGING

Gage Blocks. New 4-page data sheet describes maker's square gage blocks including rectangular gage blocks and micro-step gaging system.—DoAll Co., Des Plaines, Ill.

Circle **603** on inquiry card.

Height Gage. New 6-page illustrated pamphlet describes maker's height gage for maintaining high accuracy in production of tools, jigs, fixtures, etc.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Circle **604** on inquiry card.

Undercut Measurement Gage. New 6-page Bulletin UMG-55 pictures and describes maker's gage for measurement of "O" ring grooves, tapers, recesses, etc.—Mueller Laboratory, 239 W. Maple Ave., Monrovia, Calif.

Circle **605** on inquiry card.

Hole Gages. New 2-page bulletin describes "Kwik-Chek" precision hole gages for gaging small diameter holes from 0.025 to 0.380 in.—New Standard Div., U. S. Expansion Bolt Co., York, Pa.

Circle **606** on inquiry card.

Internal Gage. New 8-page descriptive Bulletin 48 illustrates maker's "Comtorplug" internal gage for precision gaging of grooves and holes.—Comtor Co., Waltham, Mass.

Circle **607** on inquiry card.

INSPECTION, TEST

Radiography. New 4-page illustrated bulletin describes maker's "Andrex" 160 kvp portable lightweight x-ray unit for industrial radiography.—Holger Andreasen, Inc., 703 Market St., San Francisco 3, Calif.

Circle **608** on inquiry card.

Testing Machines. New 8-page Bulletin RG-14-55 pictures and describes maker's universal testing machine, cable testers, portable hardness testers, etc.—Riehle Testing Machines Div., American Machine and Metals, Inc., E. Moline, Ill.

Circle **609** on inquiry card.

Hardness Tester. New 4-page descriptive leaflet illustrates maker's portable "Brinell" hardness tester used in rolling mills, foundries, forges, machine shops, arsenals, navy yards, etc.—Andrew King, Ardmore, Pa.

Circle **610** on inquiry card.

Dye Penetrant. New 4-page folder illustrates maker's "Spotcheck" dye penetrant in pressurized cans for finding cracks, seams, porosity and other defects open to surface in non-porous materials.—Magnaflux Corp., 7321 Ainslie Ave., Chicago 31, Ill.

Circle **611** on inquiry card.

TEST CHAMBERS

Test Chambers. New 4-page Data Sheet 11.0-9 describes application of maker's control instruments on International Radiant environmental testing chambers, and general specifications on types of programs and standard control instruments available for altitude, relative humidity, and temperature control.—Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.

Circle **612** on inquiry card.

Test Chambers. New 4-page leaflet describes and illustrates maker's environmental test equipment for temperature, humidity, and altitude; fungus-humidity test chamber, etc.—Hieatt Engineering Co., 2228 N. Hollywood Way, P. O. Box 349, Burbank, Calif.

Circle **613** on inquiry card.

Test Chamber. Two new 2-page bulletins describe maker's humidity chamber and low-temperature chamber for temperatures from ambient to —150 F.—Environmental Equipment Corp., 369 Linden St., Brooklyn 27, N. Y.

Circle **614** on inquiry card.

Answers to I.Q. Quiz on page 778

1.—b	4.—d	7.—a
2.—a	5.—a	8.—c
3.—d	6.—d	

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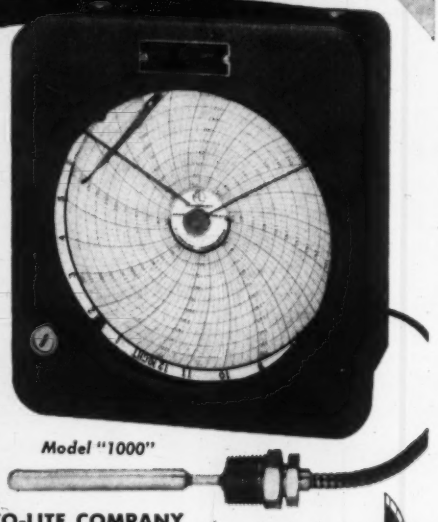

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NEW LITERATURE

COMPUTING

Analog Computing. Four new 2-page bulletins describe and illustrate maker's "Model-1100" variplotter, "Type 16-26C" servo voltmeter, "Type 16-31V" function generator group and "Type 16-31R" computer group for analog computation and simulation.—Electronic Associates, Inc., Long Beach, N. J.

Circle **615** on inquiry card.

Tape Readers. New 2-page bulletin describes maker's "Model FK-104" coded automatic keyboards for producing electrical pulse codes from manual key entries. Bulletin TF-3 describes paper tape readers for reading perforated tapes at rates up to 60 characters per second.—Soroban Engineering, Inc., Box 117, Melbourne, Fla.

Circle **616** on inquiry card.

Digital Computing. New 4- and 6-page bulletins describe and illustrate maker's digital computing systems and components, and automatic-control and data-handling equipment Also unitized gating and "logic" units. —Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

Circle **617** on inquiry card.

Computing Components. New 2-page bulletin illustrates maker's electronic analog computing components. —George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Circle **618** on inquiry card.

COUNT, TIME

Decade Counting. New set of 2- and 4-page bulletins (411, 1700, 1716, 1720) describe maker's "Model 411" oscilloscope, "Model 1700" decade counting units, "Model 1720" preset decade counting units, "Model 1716" 20 Mc binary scaler, and "Model 504" digital recorder.—Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

Circle **619** on inquiry card.

Counter. New bulletin describes maker's "Vary-Tally" multiple-unit reset-counter for obtaining numerical breakdowns of parts, products, etc.—Veeder-Root, Inc., Hartford 2, Conn.

Circle **620** on inquiry card.

Electronic Timers. New bound set of 2-page bulletins (155, 353, 651, 653, & 654) picture and describe maker's electronic delay timer; repeat-cycle timers (Models 1, 2 & 3); and interval timers (Types 12 MC and 60 MC).—G. C. Wilson & Co., Huntington, W. Va.

Circle **621** on inquiry card.

Timing Control. New 2-page bulletin describes maker's "Type D494 Meritrol" timer used on air pressures to 50 psi. and comprising timer and solenoid valve.—Emmett Machine & Mfg., Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.

Circle **622** on inquiry card.

OPTICS

Mercury Lamps. New 64-page issue of "General Electric Review" (Vol. 58, No. 2) features articles on mercury lamps, atomic piles, plant layout,

the ASA, etc."—General Electric Co., Schenectady 5, N. Y.

Circle **623** on inquiry card.

Brightness Meter. New 4-page leaflet describes maker's "Spectra" meter for measuring brightness of a small spot from remote locations.—Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif.

Circle **624** on inquiry card.

Optical Instruments. New 24-page Booklet U-1 describes maker's "Axicon" new optical element and its application to alignment problems.—Eastman Kodak Co., Rochester 4, N. Y.

Circle **625** on inquiry card.

Optics Manufacturing. New 16-page folder describes and illustrates company's personnel, history, equipment, capabilities for manufacture of precision optics.—William I. Mann Co., Monrovia, Calif.

Circle **626** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Oscillographs. New 8-page booklet lists salient points of maker's cathode-ray oscillographs and accessory instruments.—Allen B. DuMont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **627** on inquiry card.

Oscillograph. New 16-page issue of "Oscillographer" (Vol. 15, No. 2) features article on "Calibrators for the Cathode-Ray Oscillograph."—Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **628** on inquiry card.

Electronic Catalog. New 48-page 1955 Catalog Supplement 60 features latest releases in radio, industrial, TV and high-fidelity equipment.—Newark Electric Co., 223 W. Madison St., Chicago 6, Ill.

Circle **629** on inquiry card.

Equipment Catalog. New 16-page catalog presents prices and description of recorder amplifiers, electronic test equipment, power supply, drum recorder, telephone relays, time-delay timers, rheostats, pyrometers, etc. available from distributor.—Herbach & Rademan, Inc., 1204 Arch St., Phila. 7, Pa.

Circle **630** on inquiry card.

Dynamometer Volt-ammeter. New 4-page issue of "Electrical Measurements" (Vol. 22, No. 3) describes and illustrates maker's a-c laboratory standard dynamometer for checking a-c instruments and measuring a-c current or voltage within frequency range of 50 to 500 cycles.—Sensitive Research Instrument Corp., Mt. Vernon, N. Y.

Circle **631** on inquiry card.

Panel Instruments. New 2-page data sheet presents description of maker's panel instrument available in edgewise- and vertically-mounted panel types.—Sensitive Research Instrument Corp., Mt. Vernon, N. Y.

Circle **632** on inquiry card.

Wave Filters. New 20-page Catalog 12-E describes maker's wave filters and equalizers for producing variation of attenuation over a range of fre-

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NEW LITERATURE

quencies.—Cinema Engineering Co., 1100 Chestnut St., Burbank, Calif.
Circle **633** on inquiry card.

Voltmeter Multipliers. New 2-page Bulletin D-2 presents data and specs on temperature coefficient, voltage rating, dielectric strength, etc. of maker's sealed resistor voltmeter-multipliers.—International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Circle **634** on inquiry card.

SW Indicator. New 4-page issue of "Hewlett-Packard Journal" (Vol. 6, No. 7) features article on "A New Standard Wave Indicator With an Expanded VSWR Scale."—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.
Circle **635** on inquiry card.

Panel Indicator. New 2-page Engineering Data Sheet presents description and specifications of maker's "Model 1145" side indicator panel indicators for amps, volts, ma, mv, etc. —International Instruments Inc., P. O. Box 2954, New Haven 15, Conn.
Circle **636** on inquiry card.

Auto Transformers. New bulletin describes maker's banked-winding for variable auto transformers.—Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I., N. Y.
Circle **637** on inquiry card.

Frequency Meters. New 6-page issue of "Biddle Instrument News" (Vol. 11, No. 1) features article on "Frahm Frequency Meters Help Ring in the New in Party Line Telephone Systems."—James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.
Circle **638** on inquiry card.

Signal Generator. New 12-page issue of "General Radio Experimenter" (Vol. 29, No. 10) features article on "A Standard Signal Generator for the 900- to 2000-Mc Range."—General Radio Co., Cambridge, Mass.
Circle **639** on inquiry card.

Ammeters, Voltmeters. New 4-page reprint from "AEG Progress" (No. 3, 1954) features article on "New Precision Moving Iron Instruments."—Donald C. Seibert, Foot of Christiana Ave., Wilmington, Del.
Circle **640** on inquiry card.

Electrometers. New 12-page bulletin describes and illustrates maker's electrometer for measuring d-c voltages, detecting static, d-c preamplifiers, voltmeters, etc.—Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.
Circle **641** on inquiry card.

Electrometer. New Bulletin P56 presents description on maker's "Cary Model 30" vibrating-reed electrometer for radioactivity measurements, mass spectrometry, electrical property measurements, etc.—Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif.
Circle **642** on inquiry card.

Panel Indicators. New 2-page bulletin illustrates maker's "Model 641" 4½ in. square panel d-c meters; "Model 642" a-c meter with high-quality

pneumatically-damped a-c movement. —Hoyt Electrical Instrument Works, Inc., Penacook, N. H.

Circle **643** on inquiry card.

Delay Generator. New Bulletin 1154 describes and illustrates maker's digital delay generator for accurate delay measurements.—Kaiser Metal Products, Inc., Bristol, Pa.

Circle **644** on inquiry card.

Test Equipment Manufacturing. New 16-page booklet describes and illustrates maker's facilities for production of electronic equipment.—Westronics, Inc., 3605 McCart St., Ft. Worth, Texas.

Circle **645** on inquiry card.

Communication Receiver. New 4-page bulletin presents specifications, design and performance characteristics of maker's "Pro-310" communication receiver.—Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y.

Circle **646** on inquiry card.

Relay Amplifier. New 8-page illustrated bulletin describes maker's relay amplifier for guided missiles, aircraft, telemetering, etc.—Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif.

Circle **647** on inquiry card.

Electrical Detector. New bulletin describes maker's "Model M-1" detector for inspecting thin films on conductive surfaces.—Tinker & Rasor, P. O. Box 281, San Gabriel, Calif.

Circle **648** on inquiry card.

POWER SUPPLIES

Power Packs. New 2-page bulletin describes maker's "Transpac" miniaturized power packs for transistor, tube applications.—Electronic Research Associates, Inc., Box 29, Caldwell, N. J.

Circle **649** on inquiry card.

Control Regulator. New 8-page Bulletin 6.04 presents description on maker's electric "Regohm" circuit control for regulating voltage by direct control of field of large alternators and generators.—Electric Regulator Corp., Norwalk, Conn.

Circle **650** on inquiry card.

Power Supply. New 8-page descriptive folder illustrates maker's standard- and laboratory-grade power supply.—New Jersey Electronics Corp., 345 Carnegie Ave., Kenilworth, N. J.

Circle **651** on inquiry card.

Germanium Rectifiers. New 4-page leaflet describes maker's germanium rectifiers featuring an oil immersed, continuously variable inductor control. —Rapid Electric Co., 2881 Middletown Rd., Bronx 61, N. Y.

Circle **652** on inquiry card.

Generators. New 4-page Bulletin G-3155 illustrates maker's complete line of "Gen-A-Matic" motor-generator electric plants.—Multi-Matic Corp., 14741 Bessemer St., Van Nuys, Calif.

Circle **653** on inquiry card.

Power Supplies. New 24-page Catalog 55 describes and illustrates maker's power supplies for manufacturing plants, research and industrial laboratories.—Lambda Electronics Corp., 103-02 Northern Boulevard, Corona 68, N. Y.

Circle **654** on inquiry card.

MAGNETICS

Plate Magnets. New 24-page Booklet B-213 presents case histories and explanations how companies use magnets to prevent iron contamination in products.—Eriez Mfg. Co., Erie, Pa.

Circle **655** on inquiry card.

Magnetic Cores. New 4-page bulletin presents specifications and data on maker's standard grades of Ferramic "S-1" magnetic cores.—General Ceramics Corp., Keasbey, N. J.

Circle **656** on inquiry card.

Magnetic Laminations. New 4-page descriptive Bulletin DMF-1 "Magnetic Test Limits for Standard EI Laminations" presents description of test methods used.—Thomas & Skinner Steel Products Co., Inc., 1184 E. 23rd St., Indianapolis, Ind.

Circle **657** on inquiry card.

DELAY LINES

Delay Line. New 10-page Technical Paper 266 describes maker's linear, passive, jitter-free, continuously-var-

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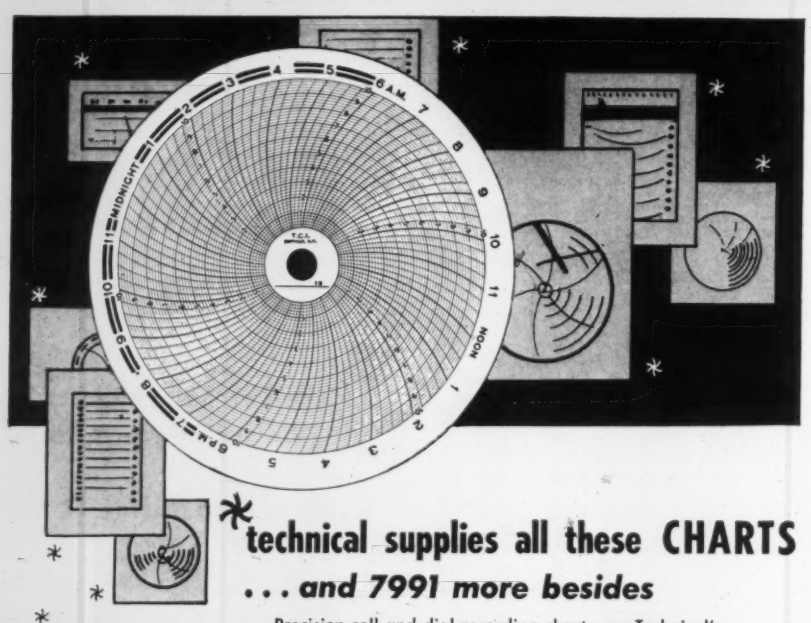

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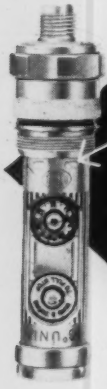

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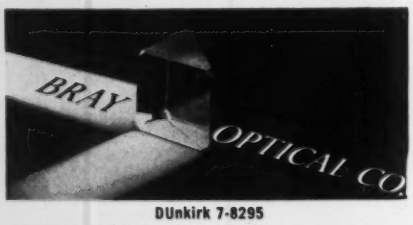

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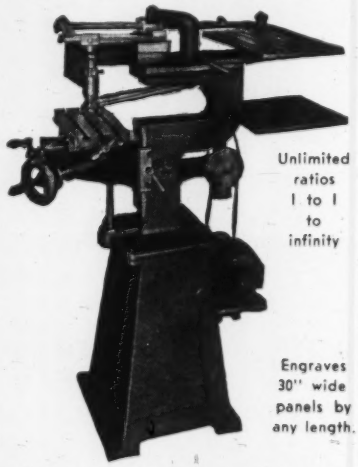

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NEW LITERATURE

iable delay line for measuring short time intervals.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **658** on inquiry card.

Delay Lines. New 4-page Data Sheet 32 describes maker's "Pluglines" delay lines featuring plug-in construction.—Jacobs Instrument Co., Bethesda, Md.

Circle **659** on inquiry card.

TUBES, TRANSISTORS

Tube Manual. New 192-page Brochure ETR-15F presents characteristics of some 2,000 tube types of which over 150 are new. Includes classification chart, characteristic curves, thumb index, etc.—Price $.50—General Electric, Schenectady 5, N. Y.

Circle **660** on inquiry card.

Junction Transistors. New 48-page manual "28 Uses for Junction Transistors" presents practical applications of junction transistors. Contains chapters on Elementary Transistor Theory, Transistorized Amplifiers, Oscillators, Control Devices and Instruments.—Price $.25.—Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle **661** on inquiry card.

Transistors. New price and data sheet covers maker's new series of radio transistors.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.

Circle **662** on inquiry card.

Silicon Diodes. New 4-page Bulletin 55S presents characteristics on maker's microwave mixer and microwave video detector diodes.—Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.

Circle **663** on inquiry card.

Germanium Diodes. New 4-page issue of "International Rectifier News" (Feb.-March, 1955) features article on "Characteristics of Point Contact Germanium Diodes."—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle **664** on inquiry card.

Electron Tubes. New 4-page bulletin pictures and describes maker's rectifiers, thyratrons, twin power triodes, voltage regulator, and reference tubes.—Chatham Electronics, Livingston, N. J.

Circle **665** on inquiry card.

RESISTORS, POTENTIOMETERS

Potentiometers. New 4-page bulletin presents electrical and mechanical specifications of maker's "Type M10T" precision multi-turn potentiometers.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **666** on inquiry card.

Potentiometers. New 2-page Bulletin D54-1 describes maker's "Types 2234 and 2235" rectilinear-motion potentiometers. Bulletin D54-A describes "Types 2134 and 2135" rectilinear potentiometers with integral trimming resistors.—Markite Corp., 155 Waverly Place, New York 14, N. Y.

Circle **667** on inquiry card.

Varistors. New 6-page Bulletin SR-3 presents applications, characteristics, current ratings, enclosures, terminations, etc. on maker's varistors (asymmetric nonlinear resistors).—International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.

Circle **668** on inquiry card.

Resistors. New 36-page Catalog R 200 describes and illustrates maker's customized resistors. 6-page Bulletin R-5501 presents construction and application data on maker's potted resistor networks.—I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Philadelphia 30, Pa.

Circle **669** on inquiry card.

Potentiometers. New 8-page Booklet 866-A presents description of maker's "Series 970" wirewound potentiometers for a-c instrument applications. Includes price list.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **670** on inquiry card.

Potentiometers. New 8-page issue of "General Radio Experimenter" (Vol. 29, No. 8) features article on "The New 970-Series Potentiometers—High-Quality Performance at Moderate Prices."—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **671** on inquiry card.

Potentiometers. New 8-page issue of "Helinews" (No. 7) features articles on analog-computer use of potentiometers and new series "Q" ten-turn precision potentiometer.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **672** on inquiry card.

Potentiometer. New 2-page Data Sheet 54-36 describes maker's "Model G" potentiometer for aircraft servo systems.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **673** on inquiry card.

Bridge Resistors. New 4-page Data Sheet EB2 (1) presents specifications of maker's complete line of d-c electrical standards and secondary standard a-c resistors.—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Circle **674** on inquiry card.

Potentiometers. New 6-page brochure describes maker's potentiometers, including single turn, rectilinear motion, and multi-turn types.—Topp Industries, Inc., 5255 W. 102nd St., Los Angeles 45, Calif.

Circle **675** on inquiry card.

RELAYS, SWITCHES

Sensitive Relays. New 4-page Technical Bulletin F 3961-4 describes maker's line of ultra-sensitive (50-microwatts) polarized d-c relays used in remote positioning, synchronization, temperature control, etc.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

Circle **676** on inquiry card.

Precision Switch. New Folder Form 84-161 describes maker's precision switches for electronic devices, telemetering controls, manual control, etc.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **677** on inquiry card.

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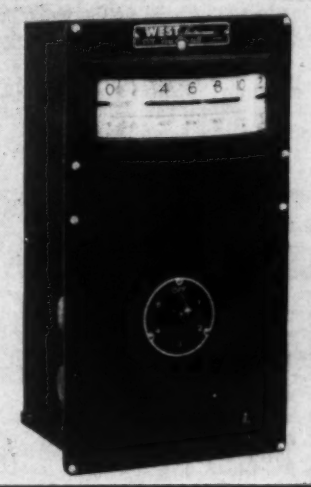
a single, central instrument

instantly reads temperatures

at up to 23 locations

WEST MULTI-POINT

HIGH RESISTANCE INDICATING PYROMETERS



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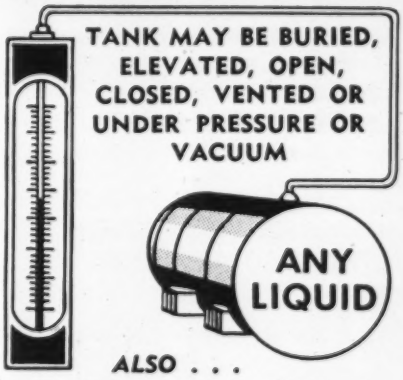

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For more information circle **151** on inquiry card.

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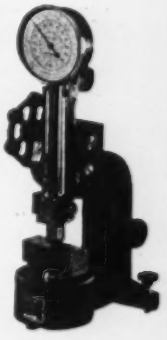

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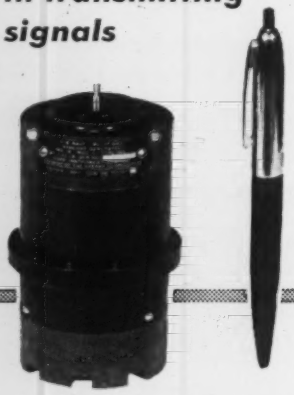
for
extreme accuracy
in transmitting
signals



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Ford Instrument's standard lines

For more information circle **133** on inquiry card.

NEW LITERATURE

Rotary Switches. New 2-page issue of "Ohmite News" (Dec.-Jan., 1954-55) features article on maker's multitap rotary switches for various switching problems.—Ohmite Mfg. Co., 3608 Howard St., Skokie, Ill.

Circle **678** on inquiry card.

Stepping Switches. New 2-page Bulletin RH-6 describes suitability of "telephone-type" stepping switches for a wide range of functions in computers.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle **679** on inquiry card.

Rotary Solenoids. New Bulletin 7 "Ledex Engineering Sketchbook" features articles on "Ledex Snap-Action Actuates Digital Converter for Instantaneous Read-Out."—G. H. Leland, Inc., Dayton 2, Ohio.

Circle **680** on inquiry card.

Circuit Breakers. New set of bulletins describe maker's single-pole thermally-operated miniature overcurrent circuit breakers, A-P-S starting winding switch, M-R motor-protecting relays, and miniature circuit breakers.—E-T-A Products Co., 5506 N. Bernard Ave., Chicago 25, Ill.

Circle **681** on inquiry card.

Relays, Components. New 12-page bulletin presents distributor's line of type relays, power transformers, chokes, selenium rectifiers, solenoid contacts, resistors, pilot lamps, etc.—Universal General Corp., 324 Canal St., New York 13, N. Y.

Circle **682** on inquiry card.

ELECTRONIC COMPONENTS

Variable Inductors. New 4-page illustrated folder describes maker's electrically-variable inductors for filter circuits, frequency control, etc.—Vari-L Co., Inc., 432 Fairfield Ave., Stamford, Conn.

Circle **683** on inquiry card.

Transformers. New 4-page bulletin describes and illustrates maker's miniature transformers.—Microtran Co., 84-11 Rockaway Beach Boulevard, Rockaway Beach, N. Y.

Circle **684** on inquiry card.

Transformers. New 12-page booklet illustrates maker's hermetically-sealed, transistor-type transformers; miniature, subminiature and microminiature transformers; etc.—Microtran Co., 84-11 Boulevard, Rockaway Beach, N. Y.

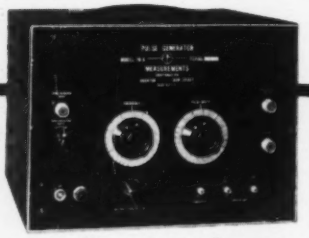
Circle **685** on inquiry card.

Transformer Cores. New 8-page issue of "Applied Magnetics" (Vol. 3, No. 2) features article on "One-Piece Wound Cores for Transformers."—Indiana Steel Products Co., Valparaiso, Indiana.

Circle **686** on inquiry card.

Coil Forms. New 4-page leaflet pictures and describes maker's square, rectangular and round tubes; resinite coil forms; bobbins; etc.—Precision Paper Tube Co., 2035 W. Charleston St., Chicago 44, Ill.

Circle **637** on inquiry card.



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REPETITION RATE: 60 to 100,000 pulses per second.

PULSE WIDTH: Continuously variable from 0.5 to 40 microseconds.

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OUTPUT VOLTAGE: 150 volts (peak) positive.

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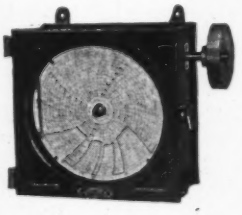

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For more information circle **154** on inquiry card.

Capacitors. New 2-page Bulletin 528 presents description of maker's "Type NT" tantalum electrolytic capacitors for applications in transistor circuits, printed circuits, etc.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle **688** on inquiry card.

Capacitors. New 6-page bulletin describes maker's paper dielectric, metallized paper and polyester film capacitors.—San Fernando Electric Mfg. Co., 1509 First St., San Fernando, Calif.

Circle **689** on inquiry card.

Tubular Terminals. New 4-page Bulletin 249-355 describes maker's miniature tubular terminals and contacts for printed circuit applications.—Malco Tool and Mfg. Co., 4025 W. Lake St., Chicago 24, Ill.

Circle **690** on inquiry card.

Connectors. New 4-page brochure presents actual size illustrations, outline drawings and specifications on maker's new "Series 1300" AN-type connectors.—Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C. 1, N. Y.

Circle **691** on inquiry card.

Microphones. New 8-page bulletin presents basic construction, operational theory and typical characteristics of maker's condenser microphones.—Frank L. Capps & Co., 20 Addison Place, Valley Stream, N. Y.

Circle **692** on inquiry card.

Terminal Boards. New 16-page illustrated Catalog T-55 describes maker's miniature molded terminal boards.—General Products Corp., Union Springs, N. Y.

Circle **693** on inquiry card.

Alligator Clips. New 2-page Bulletin 172 describes maker's "Mini-Gater" clips.—Mueller Electric Co., 1583 E. 31st St., Cleveland 14, Ohio.

Circle **694** on inquiry card.

MECHANICAL COMPONENTS

Supporting Structure. New 4-page leaflet describes maker's "Twist-Rack" supporting structure made of formed carbon steel channel.—P-W Industries, Inc., Duncan & Melrose Sts., Philadelphia 24, Pa.

Circle **695** on inquiry card.

Chassis Slides. New 6-page Leaflet 300 describes and illustrates maker's slides for use with electronic equipment, racks, and panels.—Grant Pulley & Hardware Corp., 31-85 Whitestone Parkway, Flushing 54, N. Y.

Circle **696** on inquiry card.

Self-sticking Signs. New 16-page Bulletin 145-C describes and illustrates maker's self-sticking accident prevention signs.—W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 12, Wis.

Circle **697** on inquiry card.

Hermetic Seals. New 4-page booklet describes maker's hermetic seals for temperatures to 1400 F and pressures to 2000 psi.—Advanced Vacuum Products, Inc., 18 Liberty St., Stamford, Conn.

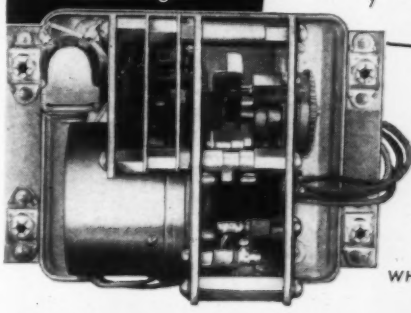
Circle **698** on inquiry card.

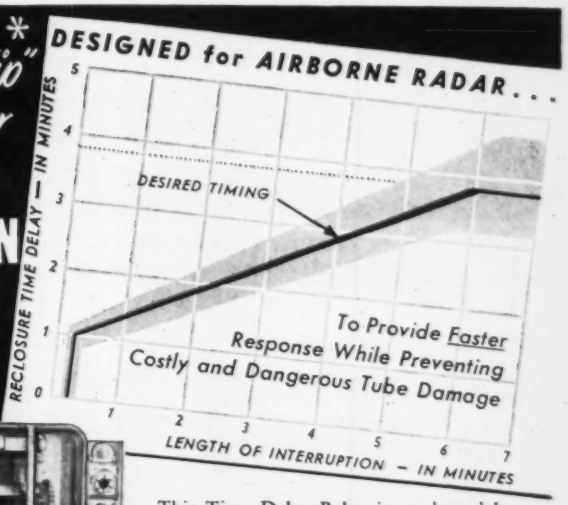
Caps and Plugs. New 4-page Catalog Sheet 55-1 presents sizes and spec-

There'd be no "blip" without power control by the

A.W. HAYDON COMPANY

*Blip — Reflected Radar Signal

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RECLOSURE TIME DELAY — IN MINUTES
DESIRED TIMING
To Provide Faster Response While Preventing Costly and Dangerous Tube Damage
LENGTH OF INTERRUPTION — IN MINUTES

This Time Delay Relay is used to delay application of plate power to vacuum tubes until filaments reach operating temperature. It provides maximum reset rate with minimum "time-out". — Eliminates danger of costly tube damage. — Provides *faster* response. Send for information about this Time Delay Relay and other special cost-saving timing devices.

WHEN TIMING POSES A PROBLEM CONSULT

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Design and Manufacture of Electro-Mechanical Timing Devices

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STEEL TYPE HOLDERS

for interchangeable numbering in a straight line. Makes serial or random numbering easy.

To use — just press thumb-clip, insert "Heavy-Duty" Shoulder-Style Steel Type, hold over position and hit with a hammer.

Furnished with round shank for press use also. Other models available for marking convexed or concaved surfaces—***with standard type.***

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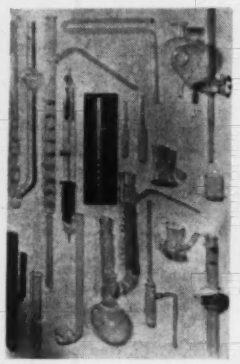

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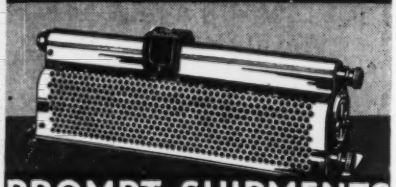

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hermetically sealed • no exposed arc • one moving part • silent • compact • motor loads to 2 hp., current loads to 35 amp • safeguards your application.

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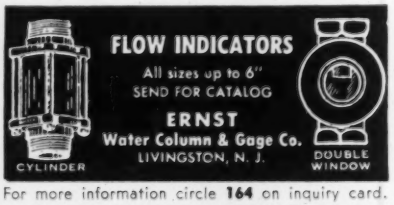

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ALL SIZES TO FIT YOUR GAGES & VALVES

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ifications of maker's "Shureclose" caps and plugs used for fittings, hydraulic components and machined parts, sealing or masking of tubing, etc.—Ray A. Scharer and Co., 3000 E. Grand Blvd., Detroit 2, Mich.

Circle **699** on inquiry card.

Mechanical Seals. New 4-page Booklet CP551 describes maker's line of "Chempro wedge-lock" mechanical seals for pumps, agitators, autoclaves and similar processing equipment.—Chemical and Power Products, Inc., New York 4, N. Y.

Circle **700** on inquiry card.

TUBING

Stainless Tubing. New 40-page Catalog 20 discusses fabrication and working of stainless-steel tubing, welding of corrosion- and heat-resisting steels, etc.—Superior Tube Co., Box 191, Norristown, Pa.

Circle **701** on inquiry card.

Fitting Assembly Machine. New 4-page Bulletin 1149 A-11 describes maker's "Model 332" hose assembly machine for assembling or disassembling detachable hose fittings.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **702** on inquiry card.

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Your present machines can be equipped with full automation, including automatic loading and gauge feedback control of size.

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Phone Hollywood 9-6278

Tube Bender. New 6-page Catalog 1141A10 describes maker's "Model 824" tube bender used in fabrication of metal tubing for fluid handling systems.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

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AIRCRAFT

Aircraft Equipment. New 36-page illustrated booklet "The Taming of the Blue" presents picture of diverse role played by Goodyear in helping to keep America first in the air.—Goodyear Aircraft Corp., Akron 15, Ohio.

Circle **704** on inquiry card.

Gyros. New 18-page set of bulletins present characteristics, specifications, and vital statistics on maker's miniature rate gyros; displacement gyro for roll and pitch control used in radio-controlled target aircraft; and armament intervalometer for rocket or missile firing systems.—American Gyro Corp., 3030 Nebraska Ave., Santa Monica, Calif.

Circle **705** on inquiry card.

FABRICATION, MACHINERY

Precision Machine Tools. New 8-page issue of "Hirschmann Highlights" (Jan. 1955) describes and illustrates "Hauser" jig borers, "Tornos" swiss-type automatic screw machine, "Nassovia" die sinker, "Censor" automatic sorting machine, etc.—Carl Hirschmann Co., Inc., 30 Park Ave., Manhasset, N. Y.

Circle **706** on inquiry card.

Electronic Manufacturer's Facilities. New 22-page booklet pictures and describes maker's plant facilities for manufacturing and testing communication instruments, bolometers, pyrometers, etc.—Servo Corp. of America, New Hyde Park, L. I., N. Y.

Circle **707** on inquiry card.

Laminating Press. New set of 2-page bulletins describe maker's laminating press; 70-ton "Type H" automatic presses; 70-ton "Type H4" press; and 30-ton "Type Q230" press.—Pasadena Hydraulic, Inc., 279 N. Hill Ave., Pasadena 4, Calif.

Circle **708** on inquiry card.

Dial Saw. New 4-page leaflet describes maker's "Model 400" dial saw for boring, hole cutting, planing and grooving.—Robertson and Ruth, Dial Saw Div., Box 534, Elmhurst, Ill.

Circle **709** on inquiry card.

Metal Fabrication. New 4-page leaflet pictures maker's fabrication of magnesium, aluminum, ferrous and non-ferrous sheet metals for electronic and allied industries.—J. F. Bingham Mfg., 69 Bay State Rd., Co., Lawrence, Mass.

Circle **710** on inquiry card.

Ticket Tube System. New set of 2- and 4-page bulletins picture and describe maker's pneumatic tube systems for sending short written messages through a pneumatic tube without a carrier.—International Standard Trading Corp., 67 Broad St., New York 4, N. Y.

Circle **711** on inquiry card.

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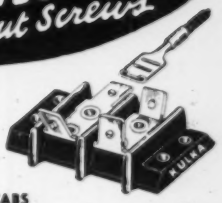
use "KLIPTITE" TERMINAL BLOCKS with VARI-ANGLED TABS

Made For AMP, Self-Locking, Wire Terminals



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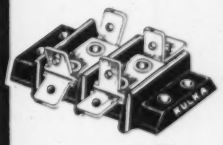

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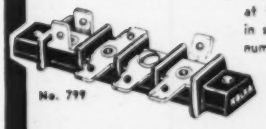

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Advertisers' Index . . .

INSTRUMENTS and AUTOMATION

A

Acromark Company 841
A'G'A Division of Elastic Stop Nut Corp. of America 823
Aircraft-Marine Products, Inc. 817
Allegany Instrument Company, Inc. 831
Alpha Metals, Inc. 745
American Chain & Cable Co. 739
American Electric Motors, Inc. 780
American Time Products, Inc. 718
Amperite Co., Inc. 777
Amplifier Corp. of America 762
Amthor Testing Instruments Co., Inc. 840
Assembly Products, Inc. 778
Automatic Electric Sales Corporation 707
Automatic Switch Co. 807
Automatic Temperature Control Company 822

B

Bacharach Industrial Instrument Company 748
Bailey Meter Company 729
Baldwin-Lima-Hamilton Corp. 680
Barksdale Valves 702
Barton Instrument Corporation 745
Bendix Aviation Corporation 769, 808
Black, Sivalls & Bryson, Inc. ..... Inside Front Cover
Bopp & Reuther, G.M.B.H. 778
Borg Corporation, George W. 700
Bowser, Inc. 693
Bray Optical Co. 838
Breeze Corporations, Inc. 711
Bristol Company 670, 674-675
Brown Instruments Division of Minneapolis-Honeywell Regulator Co. 754-755
Bruno-New York Industries Corporation 748
Burroughs Corp., Electronic Instruments Div. 827

C

Chatillon & Sons, John 767
Clifton Precision Products Co., Inc. 705
Commercial Research Laboratories, Inc. 713
Consolidated Engineering Corporation 735, 762, 820, 836
Cosa Corporation 819
Crawford Fitting Co. 738
Crescent Insulated Wire & Cable Co. 688
Crucible Steel Company of America 709

D

Dahl Company, George W. 751
Davis Instruments 734
DeJur-Amsco Corporation 765
Detectron Corporation 830
Du Mont Laboratories, Inc., Allen B. 776
Dwyer Mfg. Co., F. W. 821

E

Electric Auto-Lite Company 834
Electric Indicator Company, Inc. 835
Elgin National Watch Company 779
Eppley Laboratory, Inc. 751
Ernst Water Column & Gage Co. 842

F

Fairchild Camera & Instrument Corporation 826
Falstrom Company 670
Farris Engineering Corporation 672-673
Ford Instrument Company 840
Foxboro Company 682-683
Friez Instrument Div., Bendix 769

G

Gaertner Scientific Corporation 758
General Electric Company 676-677, 678-679, 763
General Precision Equipment Corporation 684-685
Goodyear Aircraft Corporation 669
Greiner Co., Emil 831
G-V Controls Inc. 818

H

Hagan Corporation 692
Hammel-Dahl Company ..... Back Cover
Hankison Corporation 821
Haydon Company, A. W. 841
Haydon Manufacturing Company, Inc. 773
Hays Corporation 721
Heiland, Div. of Minneapolis-Honeywell Regulator Co. 775
Heise Bourdon Tube Company, Inc. 759
Helicoid Gage Div. 739
Hewlett-Packard Company 701
Hoke Incorporated 781
Hughes Research and Development Laboratories 843
Hycon Mfg. Company 731

I

Illinois Testing Laboratories, Inc. 779
Imperial Brass Mfg. Co. 821
Indiana Steel Products Company 822
Industrol Corporation 762
Instrof Incorporated 756
Instrument & Control Consultants 842

J

Jackson Co., Byron 690-691
Jan Hardware Manufacturing Co., Inc. 750
Jerguson Gage & Valve Company 746
Jessup Engineering and Development Company (Instrument & Control Consultant) 842

K

Kearfott Company, Inc. 761
King Engineering Corp. 834
Kirk and Blum Mfg. Co. 825
Kulka Electric Mfg. Co., Inc. 843

L

Lapp Insulator Co., Inc. ..... Inside Back Cover
Leeds & Northrup Co. 722
Leslie Co. 704
Levin & Son, Inc., Louis 818, 842
Lewis Engineering Co. 694
Librascope, Inc. 687
Liquidometer Corp. 818
Littleford Bros., Inc. 760

M

Mack Electric Devices, Inc. 842
MacKenzie Walton Co. 823
Magnetic Metals Company 772
Mallory & Co., Inc., P. R. 706
Manning, Maxwell & Moore, Inc. 708
Marsh Instrument Co. 823
Marshalltown Mfg. Co. 748
Measurements Corporation 840
Mercoid Corporation 826
Meriam Instrument Company 744
Meyer-Opticraft, Inc. 828
Mico Instrument Co. 841
Midwestern Instruments 737
Minneapolis-Honeywell Regulator Co., Industrial Division 754-755
Moeller Instrument Company 779
Monsell Company, John R. 832
Mooq Valve Co., Inc. 689
Moore & Company, Samuel 743
Moseley Co., F. L. 768

N

Nash Engineering Company 720
New Hermes Engraving Machine Corp. 832
Niagara Blower Company 771

O

Office National d'Etudes et de Recherches Aeronautiques 752
Offner Electronics Inc. 714
Ohmite Manufacturing Company 732

P

Pacific Div., Bendix 808
Palmer Thermometers, Inc. 837
Panalarm Products, Inc. 757
Parker Appliance Co. 715
Peerless Electric Company 698
Philadelphia Scientific Glass Co. 842
Philadelphia Thermometer Co. 820
Post Machinery Co. 747
Powers Regulator Co. 712
Preis Engraving Machine Co., H. P. 838
Production Instrument Company 819

R

Radiation, Inc. 716
Republic Aviation 843
Rex Rheostat Co. 842
Roller-Smith Corporation 719
Rubicon Company 825

S

Sanborn Company 681
Scam Instrument Corporation 752
Schaevitz Engineering 819
Scherr Optical Tools, Inc., Geo. 820
Schrader Instrument Co. 842
Shore Instrument & Mfg. Co., Inc. 839
Skinner Electric Valve Div. 717
Smith Co., S. Morgan 774
Snyder Co., Lee Grant 842
Sorensen & Co., Inc. 770
Southern Electronics Corporation 753
Southwestern Industrial Electronics Co. 766
Sprague Engineering Corporation 822
Standard Electric Time Company 741
Statham Laboratories 742
Superior Electric Company 703

T

Technical Charts Incorporated 838
Texas Instruments, Incorporated 697
Thermo Electric Co., Inc. 764

U

Uehling Instrument Co. 839
Unertl Optical Co., John 834
United States Radium Corporation 760

V

Vapor Recovery Systems Co. 829
Veeder-Root Incorporated 710
Viking Electric 749

W

Wallace & Tiernan Incorporated 699
Waterman Products Co., Inc. 833
Weckesser Co. 832
Welch Scientific Company, W. M. 727
West Instrument Corporation 839
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Advertised Products								
1	21	41	61	81	101	121	141	161
2	22	42	62	82	102	122	142	162
3	23	43	63	83	103	123	143	163
4	24	44	64	84	104	124	144	164
5	25	45	65	85	105	125	145	165
6	26	46	66	86	106	126	146	166
7	27	47	67	87	107	127	147	167
8	28	48	68	88	108	128	148	168
9	29	49	69	89	109	129	149	169
10	30	50	70	90	110	130	150	170
11	31	51	71	91	111	131	151	
12	32	52	72	92	112	132	152	
13	33	53	73	93	113	133	153	
14	34	54	74	94	114	134	154	
15	35	55	75	95	115	135	155	
16	36	56	76	96	116	136	156	
17	37	57	77	97	117	137	157	
18	38	58	78	98	118	138	158	
19	39	59	79	99	119	139	159	
20	40	60	80	100	120	140	160	

New Instruments										
201	221	241	261	231	301	321	341	361	381	401
202	222	242	262	282	302	322	342	362	382	402
203	223	243	263	283	303	323	343	363	383	403
204	224	244	264	284	304	324	344	364	384	404
205	225	245	265	285	305	325	345	365	385	405
206	226	246	266	286	306	326	346	366	386	406
207	227	247	267	287	307	327	347	367	387	407
208	228	248	268	288	308	328	348	368	388	408
209	229	249	269	289	309	329	349	369	389	409
210	230	250	270	290	310	330	350	370	390	
211	231	251	271	291	311	331	351	371	391	
212	232	252	272	292	312	332	352	372	392	
213	233	253	273	293	313	333	353	373	393	
214	234	254	274	294	314	334	354	374	394	
215	235	255	275	295	315	335	355	375	395	
216	236	256	276	296	316	336	356	376	396	
217	237	257	277	297	317	337	357	377	397	
218	238	258	278	298	318	338	358	378	398	
219	239	259	279	299	319	339	359	379	399	
220	240	260	280	300	320	340	360	380	400	

New Literature										
501	521	541	561	581	601	621	641	661	681	701
502	522	542	562	582	602	622	642	662	682	702
503	523	543	563	583	603	623	643	663	683	703
504	524	544	564	584	604	624	644	664	684	704
505	525	545	565	585	605	625	645	665	685	705
506	526	546	566	586	606	626	646	666	686	706
507	527	547	567	587	607	627	647	667	687	707
508	528	548	568	588	608	628	648	668	688	708
509	529	549	569	589	609	629	649	669	689	709
510	530	550	570	590	610	630	650	670	690	710
511	531	551	571	591	611	631	651	671	691	711
512	532	552	572	592	612	632	652	672	692	
513	533	553	573	593	613	633	653	673	693	
514	534	554	574	594	614	634	654	674	694	
515	535	555	575	595	615	635	655	675	695	
516	536	556	576	596	616	636	656	676	696	
517	537	557	577	597	617	637	657	677	697	
518	538	558	578	593	618	638	658	678	698	
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520	540	560	580	600	620	640	660	680	700	

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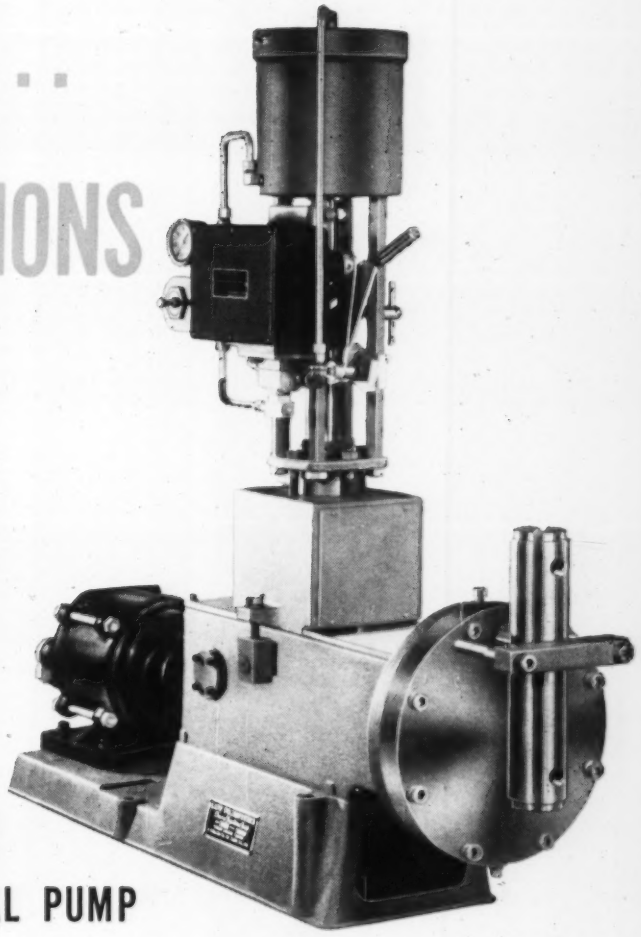

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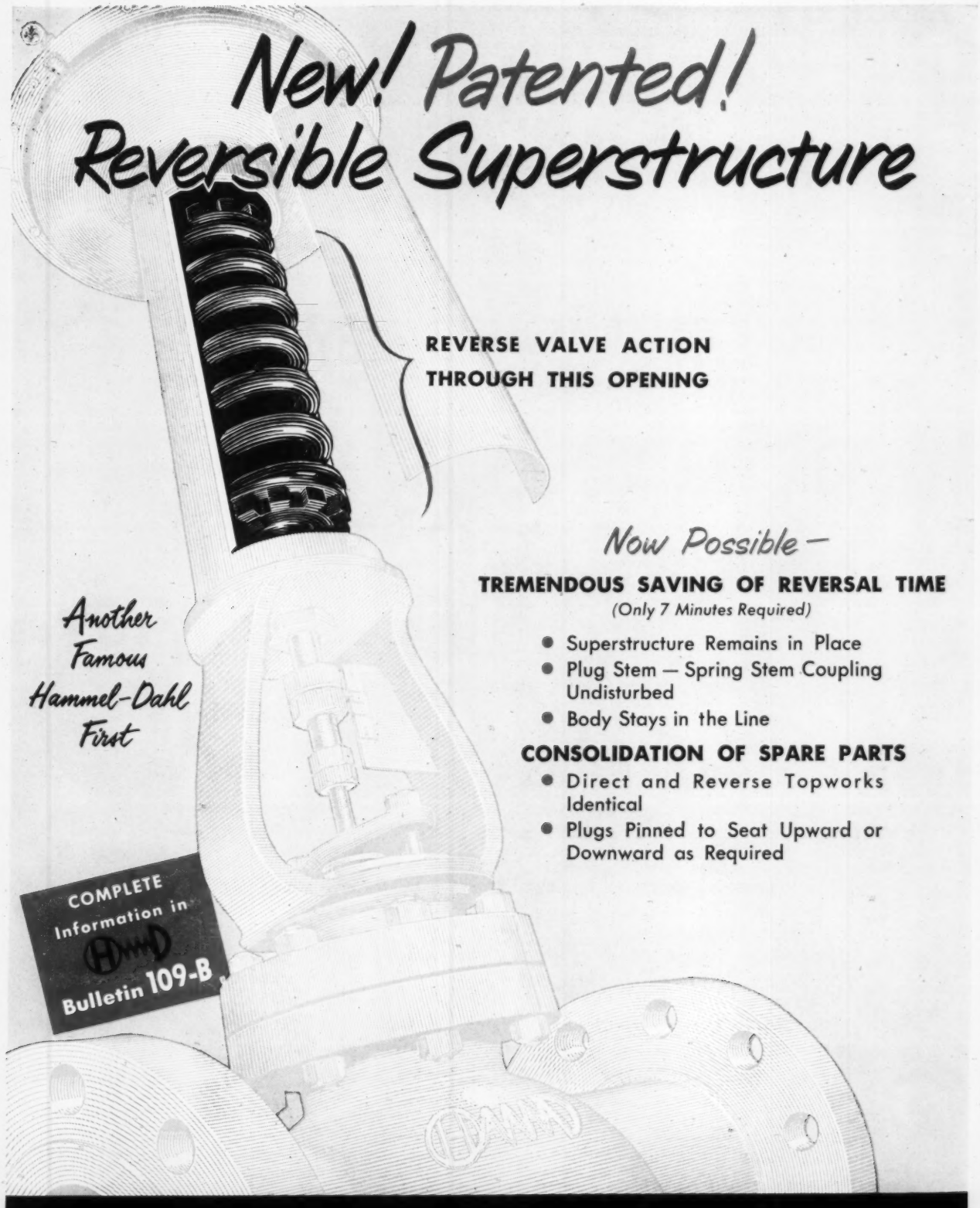

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